CIVIL ENGINEERING

APR 7 1936

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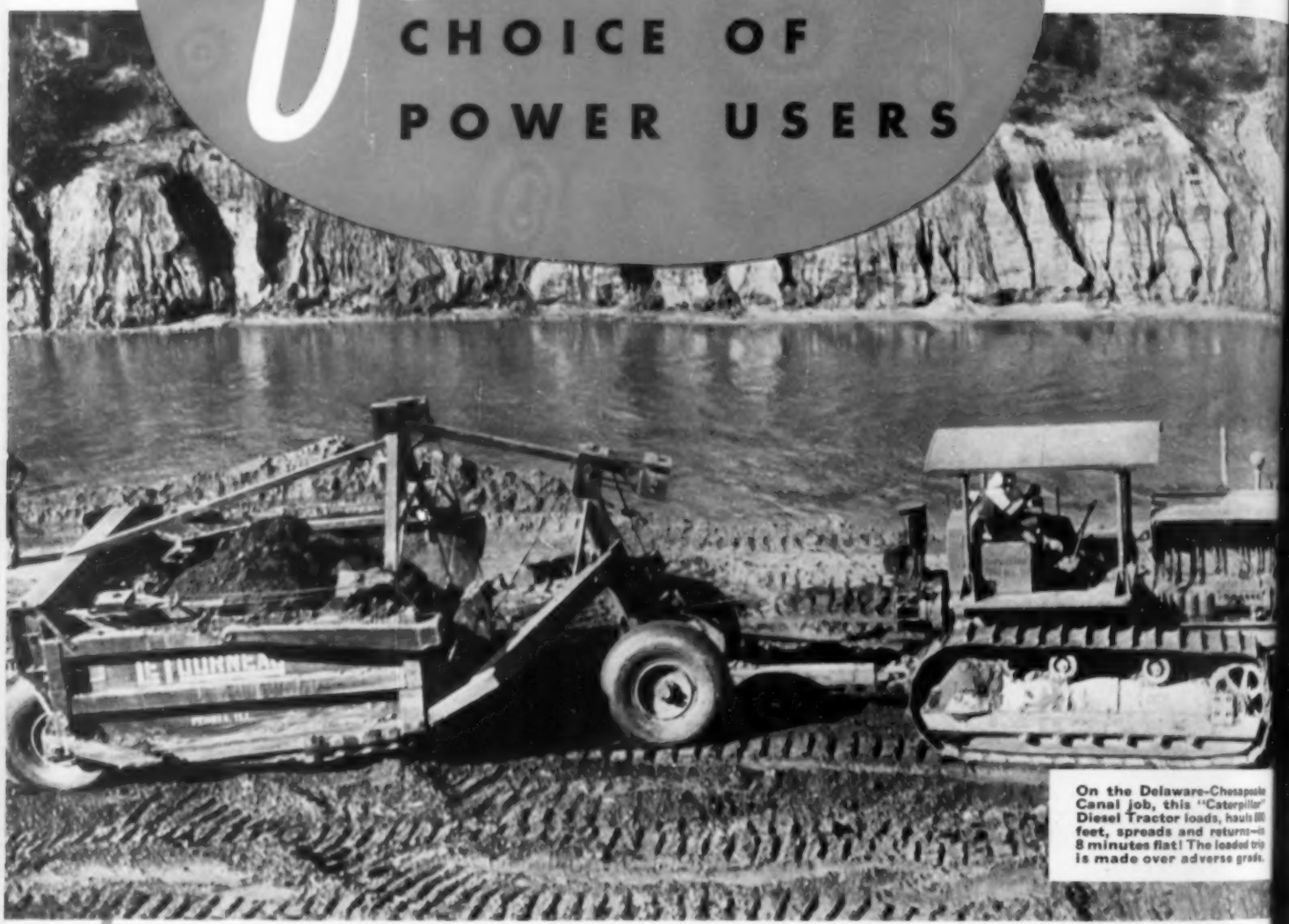
TRANSCONTINENTAL TRAINS VIE WITH AUTOS AND PEDESTRIANS FOR USE OF STREET IN SYRACUSE, N.Y.
A Problem of Long Standing Will Be Solved by the Current $17,000,000 Grade Elimination Project

Volume 6 — Number 4

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

APRIL 1936

first CHOICE OF POWER USERS



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Among Our Writers

RALPH BUDD has been in railroad work for 37 years. He has served as chief engineer of the Panama Railroad, the Spokane, Portland, and Seattle Railway System, and the Great Northern Railway. From 1919 to 1932 he was president of the latter system. Since 1932 he has been president of the Burlington Lines. It was due to his vision that the streamlined Zephyr was built.

RALPH H. CHAMBERS has had 43 years of experience in connection with hydraulic, subaqueous, and hydro-electric structures. He has specialized in deep and difficult foundations, particularly in New York City, where he had part in the design or construction of a large number of important buildings in the lower part of Manhattan.

SCOTT B. LILLY has taught for 17 years of his professional life. The first 3 years he was at Cornell University and the last 14 at Swarthmore College, Pa. During 14 of the 17 years referred to, he taught hydraulics.

ANDERS BULL holds the degree of mechanical engineer from the Technical College of Christiania, Norway, and has also studied in the electrical field. His European experience includes designing electric power plants, radio-telegraphy, and experimental chemical work. Since 1909 Mr. Bull has been largely employed in New York City, on the design of subways, bridges, and tunnels.

DAVID C. WILLIAMS graduated from the University of Oregon in 1932, received a Rhodes scholarship, and studied for three years at Oxford University. He has come, under a Bridgham fellowship, to Columbia University, where he is doing research work on the effects of large gusset-plate joints in suspension bridge towers and roof trusses.

N. F. PITTS has been connected with the Department of Engineering of the City of Syracuse for the past 22 years. Since 1924 he has been chief engineer of the department, and for the past 8 years has also served as chief engineer of the Syracuse Grade Crossing Commission and city engineer of Syracuse.

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VOLUME 6 NUMBER 4

A Million Miles of New Railway Travel

Lessons from the Experience of the Burlington Road with Light-Weight Diesel-Powered Trains

By RALPH BUDD
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PRESIDENT, CHICAGO, BURLINGTON AND QUINCY RAILROAD, CHICAGO, ILL.

WHEN in 1934 the Burlington Railroad pioneered with its light-weight Diesel-engined "Zephyr," many older railroad men were frankly skeptical. It broke clear athwart their venerable traditions. So it was on the defensive and had to prove its metal in more than one sense. However, other roads quickly followed its lead so that in less than a year nine more trains, from "way down East" to the Far West were added. Already the four trains of the Burlington Lines have approximated a million miles of travel. From this appreciable experience and his special point of vantage, Mr. Budd draws lessons that every engineer in transportation is waiting to learn. Answering many leading questions, he shows wherein the Zephyrs have justified the faith of their promoters, and points to further significant developments already under way. Those who are interested in the design and early performance of the original Burlington Zephyr are referred to a former article by Mr. Budd which was published in the August 1934 issue.

ON November 11, Armistice Day, 1934, the first stream-lined train in America was placed in operation on a regular passenger schedule. It was and is known as the Burlington Zephyr and makes 500 miles daily, from Lincoln, Nebr., through Omaha and St. Joseph to Kansas City, and back to Lincoln. Its total mileage in regular service to the end of 1935 was 202,242. This train and other Diesel-powered trains placed in service subsequently, as shown in Fig. 1, had made up to February 29, 1936 (the latest data available), approximately the total mileage given in Table I. The Union Pacific three-car stream-lined train of aluminum construction, which was brought out in February 1934, was placed in regular service between Kansas City and Salina on January 31, 1935. As it was not equipped with a Diesel engine its performance is not included here.

It is expected that the total mileage of the four Zephyrs will reach the million mark by April 30, 1936. While still not very great when compared with total American passenger train mileage, nevertheless this record is sufficient to use for intelligent analysis, and together with data for other Diesel-powered trains, serves the purpose of pointing to certain trends and conclusions that can be based only on experience. Although these comments refer solely to the observations of the Burlington Lines, they are believed to be typical of these new train types.

THE MARK TWAIN ZEPHYR IS CHRISTENED AT HANNIBAL, MO.
By the Humorist's Granddaughter—"Tom Sawyer," "Becky Thatcher," and "Huck Finn" Look on

LEADING QUESTIONS ARE PRESENTED

Any new system that vitally affects the daily lives of many people has to establish its value. Doubts and skepticism must be met. Pertinent questions must be answered. Some of these, as regards the Zephyrs, have an engineering bearing and some have a general or popular flavor. Some of these questions can be answered quite positively, and the replies to others, by their very nature, are indeterminate. Our experience as related to many specific inquiries connected with the operation of the Zephyr trains will be recounted.

How Fast Do the Zephyrs Run? The Twin City Zephyrs run 90 to 95 miles an hour on some parts of practically every trip. The average speed for 431 miles between Chicago and St. Paul, including six stops, is 66.3 miles an hour. When the station stops are short and the trains, therefore, are able to depart practically on time, the maximum speed necessary to make the schedule is 80 miles an hour, except for a few miles between Chicago and Aurora, where it is 85 miles an hour. The objective of the operating officers and the effort of the train crews is to hold the maximum speed as low as

possible, that is, to have the fastest part of the run approximate, as nearly as possible, the average speed.

The Lincoln–Omaha–Kansas City Zephyr averages 60 miles an hour between Lincoln and Omaha, and 50 miles an hour, including 11 stops, between Omaha and Kansas City, 195 miles. The highest speed is approximately 80 miles an hour for this train, and also for the "Mark Twain Zephyr" which averages 40 miles an hour on its 442-mile round trip, during which it makes 60 stops.

TABLE I. RECORD OF STREAM-LINED PASSENGER TRAINS, DIESEL-POWERED, TO FEBRUARY 29, 1936

PLACED IN SERVICE	NAME	RAILROAD	RUN	MILEAGE	REMARKS
Nov. 11, '34	Burlington Zephyr	C. B. & Q.	Lincoln–Omaha–Kansas City	262,304	Stainless steel
Apr. 1, '35	Flying Yankee	B. & M.	Boston–Portland–Bangor	209,282	Stainless steel
Apr. 21, '35	Twin Zephyrs	C. B. & Q.	Chicago–Twin Cities	512,412	Stainless steel
June 5, '35	Comet	N. Y. N. H. & H.	Boston–Providence	115,234	Aluminum
June 8, '35	City of Portland	U. P.	Chicago–Portland	86,360	Aluminum
June 24, '35	Royal Blue	B. & O.	New York–Washington	47,964	Aluminum
July 10, '35	Rebels	G. M. & N.	New Orleans–Jackson, Tenn.	164,020	Cor-ten steel
Oct. 28, '35	Mark Twain Zephyr	C. B. & Q.	St. Louis–Burlington	64,166	Stainless steel

Are They Usually on Time? The four trains have made their schedules 94 per cent of the time. This compares with 60 per cent for other passenger trains on comparable runs. These other trains, however, have been no more than 30 minutes late 90 per cent of the time. Each of the Twin Zephyrs between Chicago and the Twin Cities makes a round trip daily, leaving Chicago and Minneapolis, respectively, at 8:00 o'clock every morning and arriving back at the starting point at 10:59 p.m. after a round trip of 882 miles, during which they are turned on wye tracks located a half mile to a mile and a half from the stations, and cleaned and stocked with provisions for the return trip. For six weeks last winter they operated through extremely severe weather conditions. This is the second winter of eminently successful operation of the first Zephyr between Lincoln, Omaha, and Kansas City. The fourth Zephyr, the Mark Twain, has performed almost perfectly since its inauguration.

Have They Shown Any Defects or Weaknesses? No structural weakness or defects of any kind have been disclosed upon continuous and careful inspection. Normal maintenance has been followed; for example wheels have been changed and turned, pistons have been renewed, and injectors have been replaced and somewhat improved. Structurally the cars have proved faultless. A fourth car has been added to the original Zephyr. It was built 16 months after the other three cars but in appearance the others seem just as new as does the later one. The availability for service of the four trains has averaged 97 per cent.

This high availability is attained by very careful inspection and by replacing the parts that wear out on quite a definite schedule. On our modern high-speed passenger engines experience has demonstrated the necessity of establishing a mileage limitation on main driver axles. We were of the opinion that this might be found desirable in connection with the motor axles of high-speed Diesel electrics, and we are making periodic examination of our motor-driven axles.

Have They Had Any Accidents? The four Zephyrs now operating regularly on Burlington rails have had nine grade-crossing accidents. They have struck four automobiles, one truck, and one road grader, and they have been run into by two automobiles and one truck. In the course of their million miles, they have run down a good many animals—cattle, horses, and mules—on the track between crossings.

Data gathered during the ten-month period, April 1935 to January 1936, when most of the Zephyr mileage was made, indicate that the Zephyrs had somewhat fewer accidents per million train miles than other passenger trains, but there was not much difference, the figures being 6.00 per million train miles for the Zephyrs and 6.94 for all other passenger trains.

On March 1, 1936, one of them, the Mark Twain, had the first accident involving another train. Five minutes before the end of its trip, it collided with a string of Pullmans at a crossover in the yards outside of the St. Louis Union Station. Speed was reduced to 20 miles an hour at the time of the collision. One of the Pullmans was completely derailed, and the front trucks of the Zephyr also were derailed, but it sustained no damage beyond some scratches, as shown by the photograph. None of its 61 passengers was injured, and it made its regular run the next morning.

What Happens When They Strike, or Are Struck by, an Automobile or Truck? The vehicles struck by Zephyr trains have been demolished or badly damaged. No damage has been done to the Zephyrs in any of the highway-crossing accidents beyond scratching and denting the stainless steel covering, and the trains have always continued on their runs and made schedule time. While the trains as a whole are light in weight, the forward truck of each train carries more weight than does the forward truck of our largest passenger locomotives.

The shape of the front, as well as its construction,

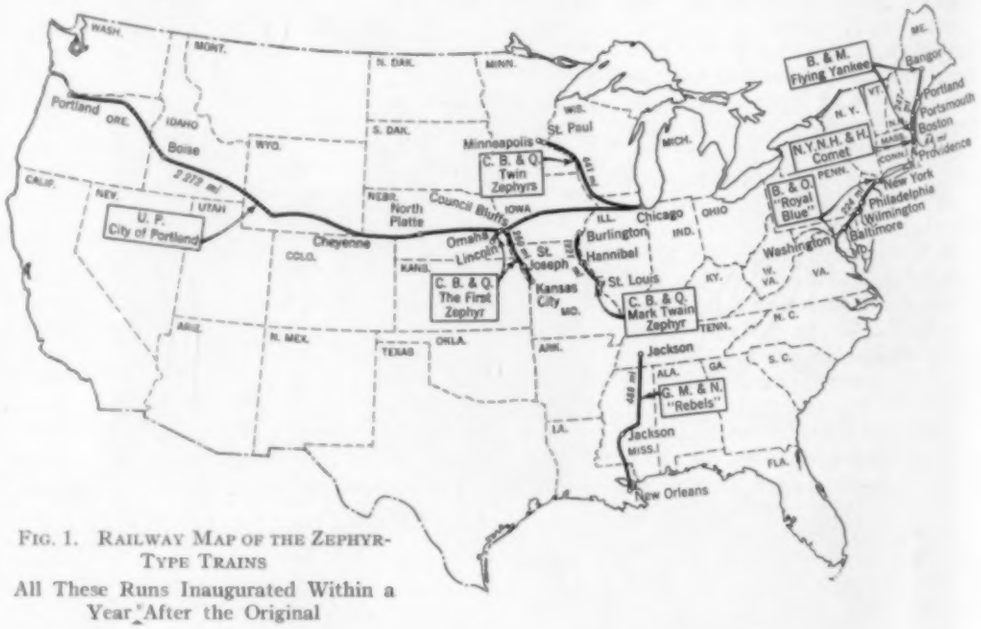


FIG. 1. RAILWAY MAP OF THE ZEPHYR-TYPE TRAINS

All These Runs Inaugurated Within a Year After the Original

combine to make the train a veritable battering ram. The shovel-nose lower section and the rounded, sloping contour above, tend to lift obstacles and throw them into the clear. The large, heavy, and exceptionally strong front car frame, made of a welded alloy (cromansil), is also the engine bed. This gives a weight of 100,000 lb on the forward truck and constitutes a steel-sheathed bullet for impact. The Zephyrs have proved to be excellent snow plows.

Have They Been Well Patronized? The patronage of the Zephyrs has exceeded expectations. Two of the trains—the first Zephyr between Lincoln, Omaha, and Kansas City, and the Mark Twain between Burlington and St. Louis—have been increased to four cars each. Since the enlargement the seating capacity, 112 and 92, respectively, has been insufficient on a number of occasions. The Twin Zephyrs have three cars each, accommodating 70 passengers, plus 16 seats in the dining section, and their capacity has been insufficient many times. During July and August 1935, approximately 5,000 people could not be accommodated.

How Much Does It Cost to Operate Them? The cost of operation for 640,942 miles to December 31, 1935 (latest data available), was 31 cents per train mile. This includes everything except depreciation and track maintenance and includes an accrual for power plant maintenance. It seems safe to say that the cost of operation is substantially less than half that for a conventional train of the same capacity at the same speeds. Actual costs

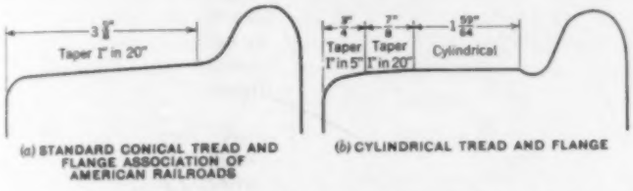


FIG. 2. ADJUSTMENT OF WHEEL TREAD AND FLANGE FOR HIGH-SPEED OPERATION

(*a*) Standard Conical Tread and Flange, Association of American Railroads; (*b*) Cylindrical Tread and Flange, for Zephyr Wheels Except Those for Power

for the Zephyrs and the best estimate for comparable steam trains are as given in Table II.

TABLE II. ITEMIZED OPERATING COSTS OF LIGHT-WEIGHT AND STANDARD TRAINS

	Zephyr Trains	Steam Trains
Maintenance of power plant or locomotive	$0.0504	$0.1830
Maintenance of train	0.0399	0.1020
Cost of fuel oil or coal	0.0139	0.1085
Cost of lubricating oil, and water	0.0093	0.0140
Wages of crew	0.1735	0.2240
Train supplies and expenses	0.0271	0.0640
Total	$0.3141	$0.6955

Are They as Safe as Other Trains? Experienced railway operating officials believe that stainless steel trains of this type are the safest trains that can be built for high-speed operation. They are strong, are free from noticeable vibration, have a low center of gravity, hold the rails remarkably well, and are easy on track. Furthermore the great strength of the material used provides maximum protection in the event of any accident, particularly if it should be accompanied by fire. Of course the deceleration of high-speed trains is a major engineering problem. We know that the Zephyrs can be stopped in a much shorter distance than conventional trains running at the same speed.

Extensive tests were made in October 1934, using the

LIGHT WEIGHT BUT STURDY—RESULTS OF COLLISION WITH A HEAVY SLEEPER AT ST. LOUIS, MARCH 1, 1936

Repairs to Sleeper, $200; to Track, $125; to Zephyr, $30

first Zephyr for the purpose. The results were published in *Railway Age* for March 23, 1935. This report by Joseph C. McCune, Assistant Director of Engineering, Westinghouse Air Brake Company, should be read carefully by anyone who desires accurate information on this important subject. The last of twelve conclusions in that report is as follows:

> No fundamental physical limitations were found which would preclude, with further development in the brake art, stops of trains of the Zephyr type from 90–100 m.p.h. in the approximate distances required for every-day conventional locomotive trains from speeds of 60–70 m.p.h.

Do They Ride Comfortably? It is difficult to get a direct comparison of the riding qualities of these trains with those of other trains because other trains seldom attain the speeds of the Zephyrs. Their articulated construction gives them certain marked advantages. There is no side motion at the couplings, and since the cars do not extend beyond the center of the articulated trucks, adjacent cars act in perfect unison. This feature, together with the low center of gravity, provides smooth and quiet performance at high speeds, especially on curves. The starting and stopping is without any jerking or bumping. The contour of all the wheels used in these high-speed trains, except the power truck wheels, has been modified so that they now have cylindrical treads instead of conical treads, as shown in Fig. 2. These substitutions have brought about a great improvement in riding comfort. Because of the light axle loads (except on the front truck) the life of wheels even at high speeds has been satisfactory. The average mileage between turnings has been as follows:

36-in. wheels (power truck)	58,844 miles
30-in. wheels (trailing trucks)	56,490 miles

WHAT OF THE FUTURE?

Will They Take the Place of Other Trains? The answer to this question takes one into the realms of prophecy, for the extent and type of passenger train evolution is far from certain. There does not seem to be any doubt, however, that some additional trains will be replaced by relatively small light-weight stream-lined trains. Perhaps some of our gas-electric cars can be so replaced, increasing patronage sufficiently to justify the expense. In other circumstances they will take the place of small

conventional-type trains and both stimulate travel and promote economy, thus bringing a good return on the investment. Each situation must be studied separately in order to make a reasonably sound decision. So much for the small three- or four-car stream-lined train, which

THE ORIGINAL ZEPHYR—WITH FOURTH CAR ADDED
Seen Leaving Omaha. It Still Holds Speed Records

is the only type that has run enough miles in actual service to afford any basis of experience.

The question also impels us to a consideration of larger stream-lined Diesel trains. How much is reduction in weight worth? How much can weight be reduced without sacrificing strength or seriously shortening the life of the cars, owing to rust or corrosion? How important is it to lower the center of gravity? How advantageous is the articulated construction in attaining high speeds with greater comfort and safety? How serious a handicap is the inflexibility of this articulated construction in ordinary service? These are some of the questions that arise concerning the cars. They affect the choice of size and type of locomotive, and that choice otherwise is not simple, involving as it does a great variety of problems.

TO MAKE CARS INTERCHANGEABLE

We know that the articulated cars and low center of gravity give added comfort and eliminate weight. In the case of small local trains where it is not imperative, or very important, to interchange cars with other trains, or to pick up or set out cars, the maximum of economy, comfort, and capacity are obtainable by light-weight construction combined with Diesel power. But the capacity of such trains is limited and inflexible. For larger trains interchangeability of cars is a necessity. There are at least three ways by which that can be accomplished.

1. By building light-weight but otherwise standard cars which, depending upon the material used, will weigh as little as one-half what a conventional car weighs. The Santa Fe Railway recently put into service such a car, which weighs 43 tons and is of maximum strength. It is built of stainless steel and hence does not rust or suffer reduction of sectional area in its structural members. Other cars of semi-lightweight construction have been built, some of which are freely interchangeable with conventional equipment. The "Hiawathas" of the Milwaukee Road are of this type. They are built of carbon steel fabricated by electric welding.

2. By building the cars as low as practicable but otherwise equipped with two trucks and couplings. Thus they are interchangeable with each other, but not with cars having couplers of standard height. The Gulf, Mobile and Northern "Rebels" are examples. They are constructed of copper–chromium–silicon–phosphorus low alloy steel.

3. By combining interchangeability and articulation so that the cars will be partly articulated; that is, by building groups of two-, three-, or four-car units that will be articulated, except that at the extreme ends of each group they would be equipped with trucks and couplers which would permit the two, three, or four articulated car groups to be set out or picked up. This modification could be applied to the construction described in both Paragraphs 1 and 2.

Partial articulation is being used in the two new light-weight stainless steel trains that are being built for the Burlington to operate between Chicago and Denver. Pairs of those cars will be interchangeable between the two trains but will not be interchangeable with cars having standard couplers, except that the forward end of the first car in each train may be coupled to any standard piece of equipment. The reduction in weight accomplished in these trains is more than half.

No one knows how great an expenditure is justified to reduce the weight of high-speed passenger-train cars. Equally significant is the fact that no one knows how much it would cost if a general program of building light-weight equipment should be undertaken. The trains that are now in service and those that shortly will be placed in service will provide the experience and the statistics upon which, later, to base more confident conclusions. But all such trains that have been built have been of such special design and construction that none of the benefits that will come from mass production have as yet been realized.

Another unknown, but probably important, factor is the precise effect of heavy, compared with lighter, axle loads upon both track and wheels when trains are regularly operated at very high speeds. What needs to

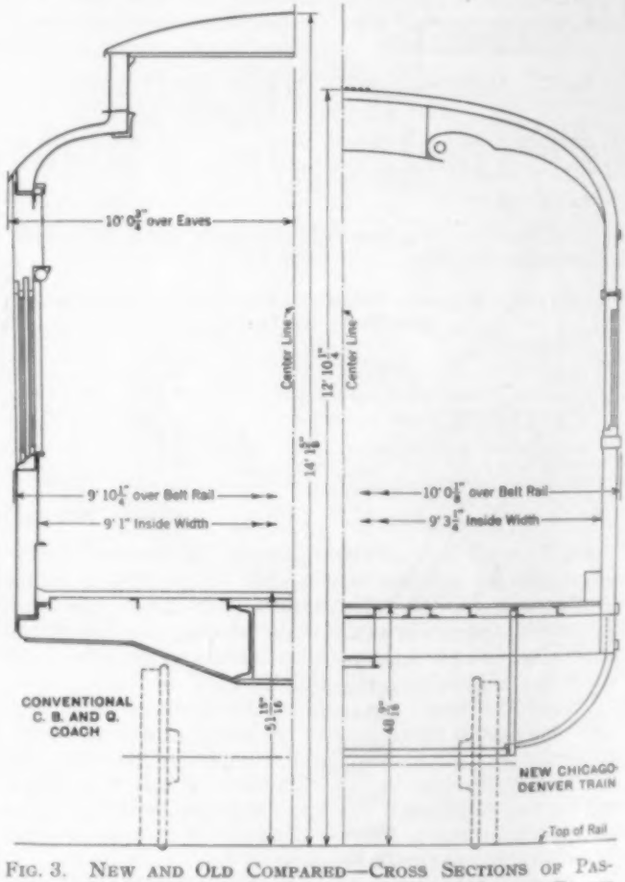


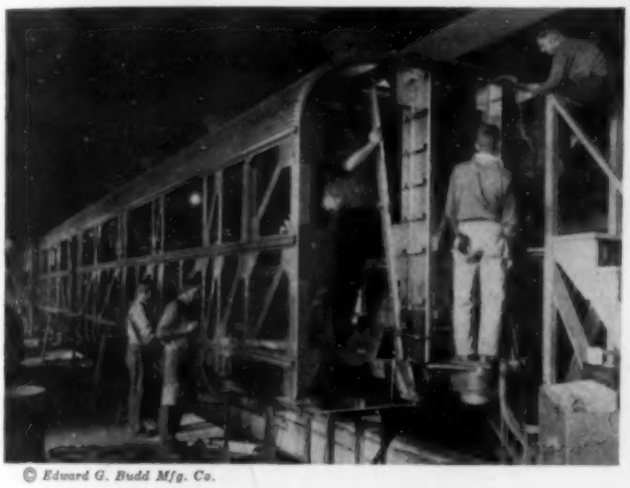
FIG. 3. NEW AND OLD COMPARED—CROSS SECTIONS OF PASSENGER COMPARTMENTS FOR REGULAR AND NEW DENVER TRAINS

be done to prepare track for these speeds is fairly well known, but how much more it costs to keep the surface and alignment in the necessary condition of near perfection, than to maintain it in condition for slower speeds, is not known; nor is it known exactly how the tendency for rails to break, may be influenced by the various types and weights of motive power and equipment.

The Burlington Railroad, after considering all the factors that enter into the problem of placing in successful operation, between Chicago and Denver, a good-sized train on a schedule of 16 hours, decided on 10 cars of stainless steel, of the cross-section shown in Fig. 3, to be pulled by a Diesel-electric double locomotive. The larger power car is in front and accommodates two 900-hp 12-cylinder units in tandem; the smaller, immediately following, has a single 1,200-hp 16-cylinder engine. The schedule of this train calls for an average speed of 64.6 miles an hour for 1,034 miles.

NEW ZEPHYRS UNDER CONSTRUCTION

Like their four predecessors, the Denver Zephyrs in their shape and appearance will follow closely the now-



© *Edward G. Budd Mfg. Co.*

AT WORK ON THE CENTER CAR OF TWIN ZEPHYR
Articulated End Casting in Place, with Collision Posts Being Applied

familiar Zephyr stream-line pattern and contour. Each will have an over-all length of about 875 ft and will consist of 10 cars aside from the two power units, embracing reclining chair cars, sleeping cars, parlor-lounge car, dining car, solarium-observation, mail, baggage, and express cars. With an exterior width of 10 ft, the cars are to be slightly wider, inside and out, than conventional equipment, and their interior design and appointments will embrace many new and certain unique features.

Their tentative schedule of 16 hours provides for departure from Chicago at the close of the business day and arrival in Denver at breakfast-time next morning, with a comparable schedule in the opposite direction. This is in contrast with the 27¾-hour west-bound schedule and the 25¼-hour east-bound running time of the fastest steam trains between these points. The new trains will save a full business day on each trip.

Two additional Zephyrs are now under construction. Consisting of six cars each plus the 1,800-hp Diesel unit, with a seating capacity of 200 each, they will embrace all the theories and principles that have been time-tested in the others. They are designed for double daily service between Chicago, St. Paul, and Minneapolis, replacing the present 86-seat Twin Zephyrs.

Their completion during the summer of 1936 will bring the Burlington's stream-line fleet up to eight trains, and its daily Diesel mileage close to 6,000.

LIGHT-WEIGHT APPLICATIONS OFFER VAST POSSIBILITIES

I have endeavored to reflect as accurately as possible the experience of nearly a million miles with these small

PREPARING FOR THE DENVER ZEPHYRS
New Track Alignment Through the Republican Valley Following the 1935 Floods

light-weight Diesel trains, and to explain that, based on experience to date, this general type of train will be projected into a new field, that of overnight service, on very fast schedules. This does not infer that all the problems to be encountered in the enlarged field are identically like those which have been met, thus far successfully, in the small Zephyrs. But there do not seem to be any inherent difficulties; and it appears to be less of an adventure into the unknown to step from the present to the larger trains, than was represented by the launching of the first Zephyrs. Again, I want to give the metallurgists great credit for the possibilities that have been opened up to the railways in the way of light-weight equipment. They have given us metals far surpassing those with which we had dealt formerly, and the modern methods of fabricating these superior metals are as essential as the materials themselves.

It is of course in the freight department of railroad operation that the great number of ton miles are moved. Even in such a year as 1935, when business was far below normal, the handling of the freight cars themselves, exclusive of the load they carried, involved approximately 400 billion ton-miles. If some of the advantages of light-weight passenger-train cars can be embodied in freight car construction, the significance to railways would be very important. If, for example, freight cars that would carry the same load should weigh 25 per cent less than they do, it would represent, when all the existing equipment has been replaced, a saving of 100 billion ton-miles. At the conservative estimate of one mill per ton mile, this would mean an economy of $100,000,000 a year. Of course freight cars would not be built of stainless steel; but other available steels do make possible a reduction of 25 per cent, or more on some types.

The significance, therefore, of these light-weight trains is not found in the comparatively small figures that they themselves represent, but in the idea that they symbolize, namely, the performing of work with a minimum of effort. This idea, I believe, will be carried out to a greater or less extent in all future railway equipment, both passenger and freight, as well as in locomotives.

Underpinning the Tower of Trinity Church

Settling of Famous New York Landmark Presents Difficult Underpinning Problem

By RALPH H. CHAMBERS

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WHEN the present Trinity Church structure was begun in 1839, the builders constructed the tower foundations on a stratum of coarse sand and gravel which must have seemed quite adequate. But this firm material was in fact only 12 ft thick, being underlain to a depth of 34 ft by a mixture of soft moist clay, fine sand, and finally quicksand. When subways were constructed in adjacent streets and the foundations for the tall buildings of the financial district were sunk nearby, measures were taken to avoid disturbing the tower foundations, but it was later discovered that the tower was out of plumb and was settling at an increasing rate with an inclination toward the east. It was thus necessary to provide underpinning of maximum capacity while removing only a very small part of the existing bearing area. It was decided to jack down to hardpan 17 steel cylindrical piers 42 in. in diameter, excavating during the process and afterward filling the piers with concrete. In view of the hazardous nature of the undertaking and the limited working area available, the means employed by Mr. Chambers for the work are of unusual interest.

TWO hundred and thirty-nine years ago, in 1696, the first Trinity Church structure was built on Broadway at the head of Wall Street, in the city of New York. The site was at that time just within the wall from which Wall Street, then the northern boundary of the colonial town, got its name. For eighty years this church was a landmark on sea and shore, but it was burned during the Revolution, in 1776. A second church was begun on the same site in 1788. Fifty years later it was taken down because of structural weakness. The present structure was begun in 1839 and completed in 1846. Since that time the population of the area now occupied by the five boroughs of New York City has increased from 391,000 to about 7,300,000 people.

The present church, which is built of brownstone in the perpendicular Gothic style, is about 79 ft wide and 166 ft long. The chapel, which projects beyond the main northerly wall at the northwest corner, is not a part of the original church. Projecting porches at the northeast and southeast corners cover the side entrances. The principal entrance, on the east side of the church at the end of Wall Street, is located in the base of the rectangular tower. The latter is 134 ft 4 in. in height, and is surmounted by an octagonal spire 140 ft 1 in. in height. The cross at the top of the spire is 280 ft 5 in. above the base of the tower.

High windows in the easterly wall of the church, on each side, make the tower practically an independent structure. Two projecting buttresses reinforce each of its four sides, except where the east wall of the church replaces the lower part of the westerly buttresses. The tower projects 44 ft beyond the east wall of the church, and is 47 ft wide, measured outside the buttresses. The center line coincides with the axis of the nave. Tower and spire are of brownstone ashlar, and the workmanship is of remarkably fine character.

When built, this tower and spire formed a commanding structure. Though still separated from other edifices by street and churchyard (in which are buried many whose names are a part of early American history) church and spire are now overshadowed by the tall buildings of the financial district. In Fig. 1 is shown a sectional plan and elevation of the tower base.

The foundation of the tower is of hard brownstone rubble masonry laid in cement mortar, which after almost a hundred years has attained such hardness and adhesion that the masonry is almost monolithic, and it is difficult to separate the stones from the mortar. The walls of the foundation form a hollow prism and the space within is filled with concrete. The bottom of the tower foundation is about 12 ft below the surface of the ground, where it rests upon a stratum of coarse sand and gravel which must have seemed very adequate when the tower was built. However, this stratum is only about 12 ft deep. Beneath it, extending down to ground-water level 22 ft below the bottom of the tower foundation, lies a mixture of soft moist clay and fine sand. Below ground-water level is a quicksand stratum about 24 ft deep, composed of a mixture of saturated clay and fine sand. This in turn rests upon the characteristic hardpan stratum overlying the rock in the southern part of Manhattan. The hardpan, which is of glacial origin, is a dense, hard mixture of boulder till, sand, gravel, and boulders. The boulders in the hardpan are of a different composition from the bedrock, and are often of considerable size. At this site the hardpan is from 12 to 15 ft in thickness, and the bedrock, which is the mica schist

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GENERAL VIEW OF TRINITY CHURCH AND CHURCHYARD LOOKING WEST FROM WALL STREET

The Street in the Foreground Is Broadway. The Church Property Is Bounded in the Rear by Trinity Place

common to Manhattan, lies 70 to 77 ft below the surface of the ground (58 to 65 ft below the bottom of the tower foundation).

When the subway was built under Broadway in 1904, some concern was felt in regard to the foundations of the tower as the west wall of the subway was planned to extend 13 ft below the tower foundation at a distance of only 9 ft. At that time Messrs. Edwin S. Jarrett and Daniel E. Moran, Members Am. Soc. C.E., served as consulting engineers to the church, and special expedients were used under their direction to prevent disturbance of the tower foundation.

There was a settlement of the westerly end of the church in 1925, after the subway under Trinity Place was built. This part was underpinned under the direction of the late H. de B. Parsons, M. Am. Soc. C.E. As the walls at the west end of the church are much lighter than the tower, it was possible to underpin them by means of steel pipe piles jacked down to hardpan.

The foundations for the Irving Trust Company building, on the southeast corner of Broadway and Wall Street, were built in 1929, and those for the new First National Bank building on the northeast corner of Broadway and Wall Street in 1932. Both foundations were carried down to rock, which at the point nearest to the foundations of Trinity tower (about 70 ft away) is 56 ft below the bottom of the tower foundation. Figure 2, a vertical cross section at the northerly face of the tower, shows the relation of the tower foundation to the Broadway subway and to the building foundations previously referred to. The underpinning shown in this figure and in Fig. 1 is that which has been installed recently.

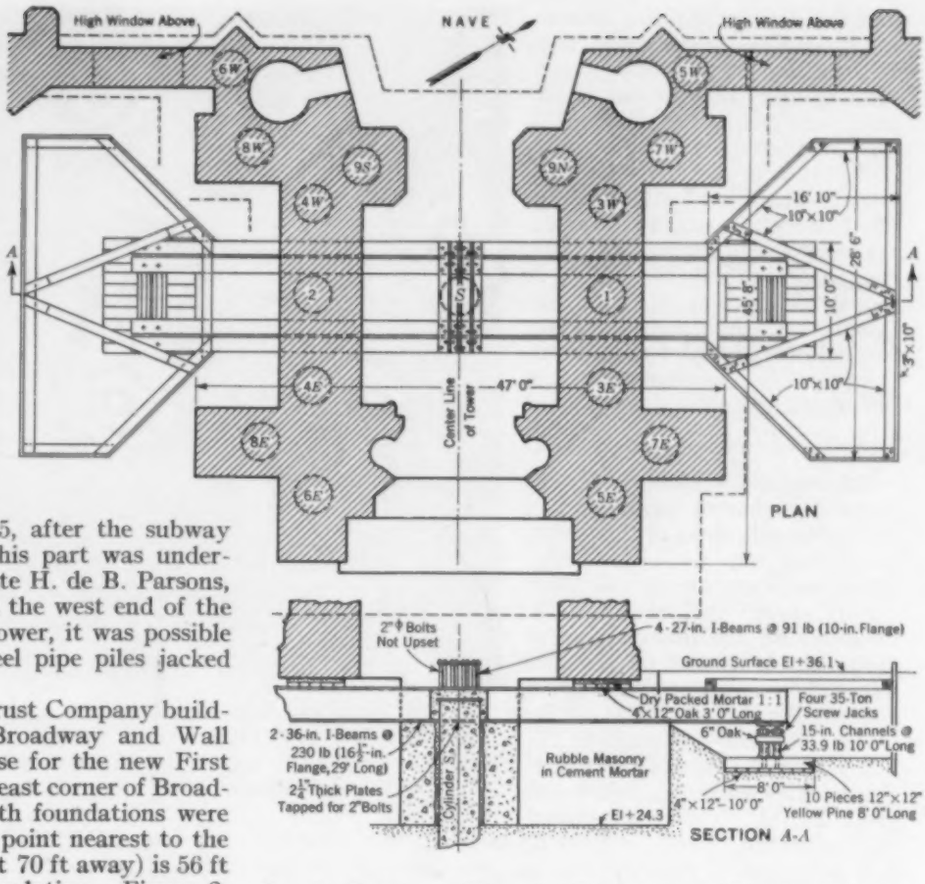

FIG. 1. SECTIONAL PLAN AND ELEVATION OF TRINITY CHURCH TOWER AT GROUND LINE

SURVEY REVEALS EXTENT OF SETTLEMENT

For some time it had been known that the easterly part of the church was moving. This was evidenced by the opening and widening of cracks, particularly in the arches over the clerestory windows. Apparently this movement had been accelerating, although no cracks had appeared in the masonry of the tower. A survey, with instruments, made in March 1935, disclosed that the tower and easterly part of the church had settled, and that the tower was leaning in such a way that its top was $7\frac{1}{4}$ in. farther north and $11\frac{3}{8}$ in. farther east than its base. Furthermore, the top of the spire was $17\frac{1}{8}$ in. farther east than its base, and although the base of the spire was $7\frac{1}{4}$ in. north of the tower base, its top was $4\frac{1}{8}$ in. south of the tower base. That is, the axis of the spire did not correspond with the axis of the tower. In addition, the top of the plinth course at the base of the tower, which presumably was level when it was built, was out of level as much as 4 in., having settled more at the easterly side. From March, when the first survey was made, to the first part of July, when the sinking of the underpinning cylinders was begun, the tower settled from $\frac{1}{8}$ to $\frac{3}{16}$ in. more.

When informed of these conditions, the church authorities decided that steps should be taken to arrest the movement then in progress and to prevent any further movement. Accordingly studies of all conditions affecting the stability of the tower were begun and underpinning plans and specifications were prepared.

The spire and tower were estimated to weigh 9,600 tons, and the foundation below ground, 2,300 tons, making a total weight of 11,900 tons resting on a soil area of about 2,500 sq ft, or an average load of about 4.8 tons per sq ft. But as the center of gravity of these loads did not correspond with the center of gravity of the foundation bearing area, the actual load on the soil at the extreme westerly side of the foundation had reached about 6 tons per sq ft. This condition was surprising since the east side was settling faster, and the tower was leaning toward the east. It is probable, however, that the tower received some lateral support on its west side from the main church structure.

It was not planned to attempt to raise or straighten the tower, as its considerable weight, resting on a comparatively small area, would have made such an attempt disproportionately expensive. Furthermore, any straightening of the tower would have caused disturbance and damage to the walls of the church, and the lean of the tower had not yet reached a point such as to be readily noticeable.

The soil under the tower was heavily overloaded. The tower was settling and moving, and would continue to settle and move until some form of additional support was provided. Since any disturbance of the soil under the foundation due to underpinning operations would undoubtedly cause some acceleration of this movement, it was obvious that temporary shoring was advisable.

In selecting the type of underpinning to be used, consideration was given to the comparatively small area of the existing foundations, the danger consequent to taking away even a small part of the existing bearing area,

and the risk involved in disturbing the soil below the foundation. It was evident that the underpinning must provide the necessary load-carrying capacity within the smallest practicable area. This in turn required that the bearing area of the underpinning must be as small as possible, therefore necessitating that it be carried down to rock, 60 to 65 ft below the bottom of the tower foundation. As this elevation was below the ground-water level, it would be necessary to use pneumatic caissons.

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BRONZE ENTRANCE DOOR, TRINITY CHURCH
The Main Entrance Is Located in the Base of the Rectangular Tower

INSTALLING TEMPORARY SHORING

As temporary shoring, it was decided to install needle beams under the side walls of the tower, projecting out on either side. These walls are about 7 ft thick at the base and are without openings for the greater part of their height, so they proved well adapted to transmit the effect of the needles to all parts of the tower. To avoid damage to the fine ashlar masonry of the tower, the needles were set below the ground level. This necessitated the excavation of two pits, one on each side of the tower, 8 ft deep and of sufficient size to provide room for the operation of screw-jacks. Holes 3 ft wide were cut through the tower foundation. As the bottoms of these holes were more than 6 ft above the bottom of the foundation, no loss of bearing area resulted.

Since the use of deep, heavy girders 60 ft long would have been difficult and expensive, a center support was provided by sinking an underpinning pier under the center of the tower (Fig. 1). The method of sinking this pier will be described later. Two needles, each consisting of two 36-in., 230-lb beams 29 ft long were placed under each side wall. The outer end of each needle was carried on four 35-ton steel screw-jacks supported on four 15-in. channels, which rested on an 8 by 10-ft timber mat. The inner ends of the needles were suspended by 32 bolts 2 in. in diameter from four 27-in., 91-lb I-beams, which ran at right angles to the needles and rested on the underpinning cylinder. An oak-plank mat 4 in. thick, 3 ft wide, and 5 ft long, was placed over each needle where it passed under the wall, and the space between the mat and the masonry of the tower was packed with mortar composed of one part quick-setting cement to one part sand. This mortar was only slightly moistened and was packed and rammed into place.

The needles were placed level, but after the dry mortar packing had set, their inner ends were raised by slacking off on the screw-jacks and tightening the 2-in. bolts, a space having been left for this purpose between the tops of the needles and the bottoms of the 27-in. beams. This was done to compensate for the subsequent shortening of the underpinning pier and deflection of the 27-in. beams under load.

Two men, operating the screw-jacks with an 8-ft lever, could produce an uplift of 30 tons with each jack, or a total of 120 tons on each end of each needle. The combined lifting force of the four needles, acting on the walls of the tower, was thus about 1,100 tons, causing a maximum stress in the medium steel needle beams of about 24,000 lb per sq in. After the needles were installed, the screw-jacks were tightened at short intervals, both day and night, until all but two of the underpinning piers had been completed.

As has been stated, the average bearing of the tower foundation on the soil was 4.8 tons per sq ft. Since the uplift of the shoring needles was 1,100 tons, the shoring was equivalent to about 230 sq ft of additional foundation area of equal value, or about 9 per cent of the total area of the existing foundation. The additional bearing provided by the shoring was about equal to the bearing area destroyed by cutting, in the foundations, 17 holes 4 ft in diameter, for the underpinning cylinders.

Seventeen underpinning piers were to be installed under the tower. Each was to consist of a steel cylinder 42 in. in outside diameter, built up of short sections which were to be jacked and excavated down to rock and

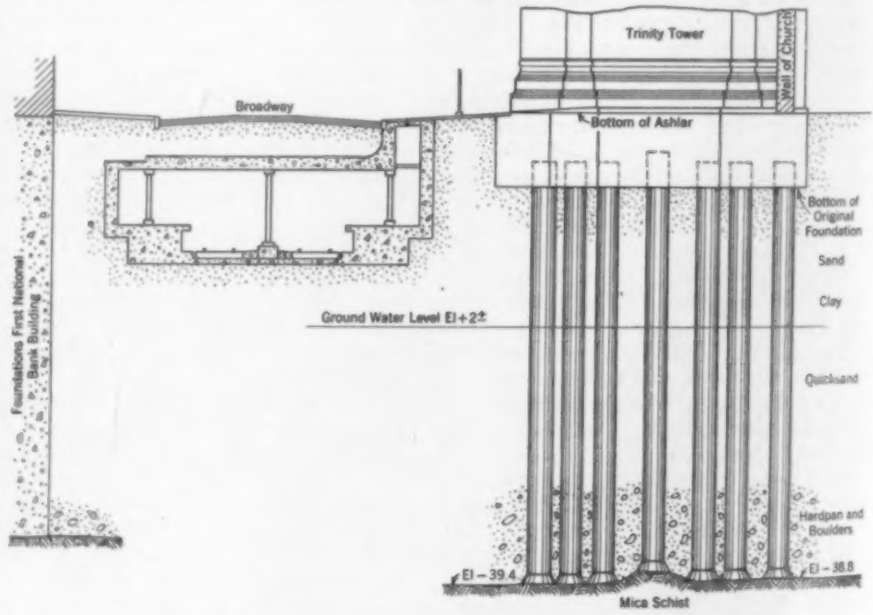

FIG. 2. SECTIONAL ELEVATION AT NORTH FACE OF TRINITY TOWER, LOOKING SOUTH
Showing Subsoil Conditions and Adjacent Subsurface Structures

then filled with concrete up to the bottom of the ashlar masonry.

Before excavating for these piers it was first necessary to dig horizontal holes through the foundation masonry to the desired location under the tower. The bottoms of these holes were about 6 ft above the bottom of the tower foundation, and as they were only about 4 ft wide, the masonry below each hole acted as an inverted arch to carry the tower loads to the soil below, thus avoiding diminution of the bearing area of the original foundation to any appreciable extent. From the bottoms of these horizontal holes, vertical shafts about 4 ft in diameter were excavated to the bottom of the foundation, and in these the first sections of the steel cylinders were set. The cylinders were then jacked down against the weight of the tower above, as the displaced soil was excavated.

In general, the bottoms of the cylinders were embedded in the soil, and no excavation was made below them until hardpan was reached. All excavating below groundwater level, about 22 ft below the bottom of the original tower foundation, was done under compressed air. As shown in Fig. 3, each cylinder section was fitted with two diaphragms, the lower about 8 ft above the bottom, and the second about 8 ft higher, forming a working chamber and an air lock, respectively. Removable doors were fitted to each of the diaphragms, together with the necessary compressed-air piping. A man in the working chamber excavated the material, which was drawn up in pails by a second worker stationed in the air lock. After six pails were lifted into the air lock, the bottom door was closed. The compressed air was then discharged from the air lock, the upper door opened, and the pails drawn up and out of the cylinder by men at the top.

The working chambers were supplied with compressed air at a pressure sufficient to balance the hydrostatic pressure and to exclude the water and quicksand from the working chamber. The maximum air pressure under which the men worked was 15.5 lb above atmospheric pressure, or about two atmospheres. Compressed air at a pressure of 100 lb was supplied to operate the pneumatic tools and drills used to excavate the hardpan and boulders. Excavation was carried on continuously and without interruption, from ground water until rock was reached, cleaned off, and the bottom of each cylinder sealed with concrete about 6 ft thick. The men under air pressure worked in three shifts per 24 hours, each shift being divided into half shifts each 3¾ hours long, with a half-hour interval between.

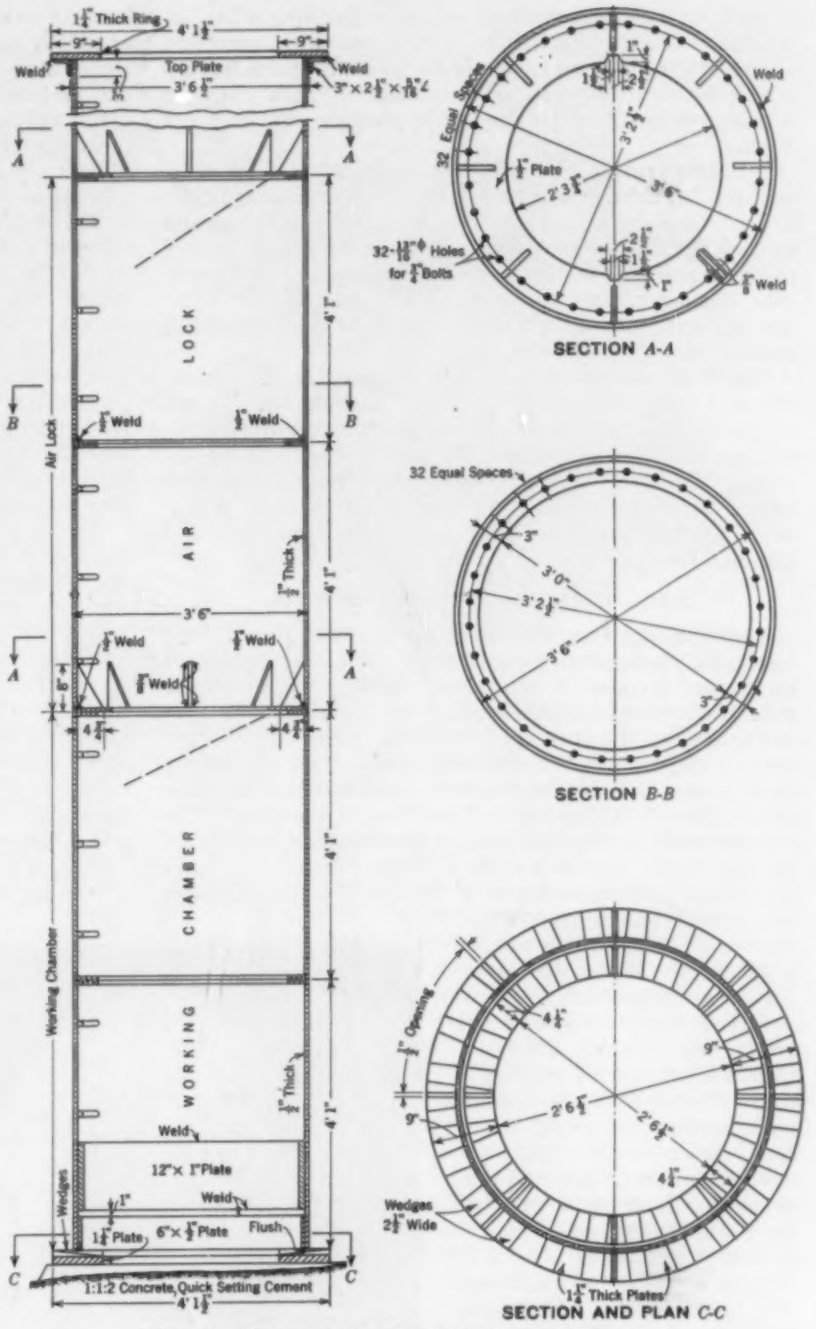

FIG. 3. DETAIL OF TYPICAL UNDERPINNING PIER

SINKING UNDERPINNING CYLINDERS

Two hydraulic jacks, each of 100 tons capacity, were used to force the steel cylinders into the soil. The maximum skin friction developed on the surface of the cylinders was from 200 to 225 lb per sq ft. The jacks were suspended from horizontal beams bearing against the masonry of the tower above. Additional sections of the cylinders were added at the top, below the jacks, as the sinking progressed. The cylinder at the center of the tower, which was used as previously described to support the ends of the shoring needles, was jacked down against steel beams supported on the ends of the needles and anchored to them by eight bolts 2 in. in diameter, thus transmitting the reaction of the hydraulic jacks to the side walls of the tower. After the shoring was removed, three of the 36-in. shoring beams were cut off and placed across the tower with their ends under the side walls and their centers bearing on the center pier. Steel wedges were then driven at the ends of the beams, and in this manner a part of the weight of the tower walls was transferred to the pier.

The steel cylinder sections were each 4 ft 1 in. long. Each consisted of a universal plate 48 in. wide, rolled to an outside diameter of 42 in., and welded. At each end

of each cylinder section was welded a flat ring 42 in. in outside diameter, 3 in. wide, and $^1/_2$ in. thick, punched about $3^3/_4$ in. on centers for bolts $^3/_4$ in. in diameter, by which the sections were to be connected. The cylinder sections were tested by an inside pressure of 50 lb per sq in.

A bearing ring $49^1/_2$ in. in outside diameter, 9 in. wide, and $1^1/_4$ in. thick, was placed at the top of each cylinder and centered by an angle guide ring. Under the bottom of each cylinder were placed eight curved plates, each 9 in. wide and $1^1/_4$ in. thick, laid in a ring $48^1/_2$ in. in outside diameter, on a concrete bed placed on rock. Twenty-four sets of steel wedges were used to insure full bearing of the cylinder on these rings.

The first three caissons, *S*, 1, and 2 (Fig. 1), were sunk, one at a time, in the order given. The others were sunk in pairs in the order in which they are numbered. Quick-setting cement was used for the bed on rock and for the caps. The top 6 in. of the cap was placed after the rest of the cap had set. It was composed of one part quick-setting cement and one part sand, mixed very dry and rammed into place.

SOME GENERAL ASPECTS OF THE WORK

According to the building code of the City of New York, the load-carrying capacity of the piers, considered as reinforced concrete columns, is 500 lb per sq in. on the area of the concrete, plus 7,500 lb per sq in. on that part of the area of the steel shell which is equivalent to 4 per cent of the area of the concrete, plus a load per square inch on the area of the concrete equal to twice the area of the steel shell, limited to 2 per cent of the area of the concrete, divided by the area of the concrete, multiplied by 16,000 lb. Since the area of the concrete is 1,320 sq in. and the area of the steel shell is 65 sq in., the area of the steel shell divided by the area of the concrete is 4.9 per cent, and the allowable load on the cylinders is about 950 tons.

If the whole weight of the tower, spire, and original foundation were carried by the 17 underpinning piers, the average load on each pier would be 700 tons. It was not possible, however, to locate the piers so that their combined center of gravity would correspond with the center of gravity of the loads, and as a result the most easterly piers might conceivably have an additional load of 75 tons each. On the other hand, it is unlikely that the entire load will be imposed upon the piers, as only about 10 per cent of the bearing area of the original foundation was destroyed by the underpinning operations.

The proportional load which each pier will carry is in the end determined by the amount of settlement taking place at that location after the pier is completed. The tower continued settling during the underpinning operations, and the piers were necessarily finished at different times. The maximum settlement of the tower from the time when the sinking of the piers was begun until the completion of the last pier was about $^7/_{16}$ in., more on the east side than on the west. Up to the time the underpinning was completed, the maximum settlement which had taken place at the location of any one pier after its completion was $^5/_{16}$ in., at Pier 1. An almost equal amount of settlement occurred after completion at Piers 2, 3E, 3W, 4E, and 4W. Computation of the stress in these columns, using a modulus of elasticity of concrete of 2,000,000 and a length of column of 70 to 75 ft, indicates that the load on these piers approximates that permitted by the building code formula. However, the driving of wedges at the ends of the beams supported by the pier *S* lightened the loads on these piers to some extent. The settlement at the two most easterly piers after their completion was considerably less than the settlement at the piers near the center of the tower, and the load on them must, accordingly, be less. No further settlement occurred after the last underpinning pier was completed.

All the work was done within a fenced-off area around the tower. The approaches to the side entrances of the church were not closed, and at no time were the church services interrupted. The outside dimensions of the fenced-off area were 84 ft (parallel to Broadway) by 51 ft, but within it the tower itself occupied an area of 44 by 47 ft, and a considerable part of the remaining area was taken up by electrically driven air-compressors, office, lockers, change house for compressed-air workers, and a space about 16 ft by 20 ft reserved for the temporary storage of excavated materials. These materials were removed at night when the Broadway traffic was at a minimum. The air-compressor plant had a capacity of 360 cu ft per min of free air, delivered at a pressure of 100 lb per sq in. for the pneumatic tools; and 514 cu ft per min of free air delivered at a pressure up to 30 lb per sq in. for the caissons.

Work was begun on June 10, 1935. Sinking of the first caisson was begun on July 9 and air pressure was turned off in the seventeenth and last caisson on September 27. The sinking of a caisson down to rock was usually completed in four days, and no caisson work was done on Saturdays, Sundays, or holidays. The cost of the underpinning work was about $100,000.

The work was done under the general direction of Hobart Upjohn, president of the New York Chapter, American Institute of Architects, and architect for Trinity Church. The construction work was done by the H. J. Deutschbein Company, of which H. J. Deutschbein, Assoc. M. Am. Soc. C.E., is president. All instrumental surveys and the inspection of the rock at the bottom of all the caissons was done by Charles Scott Landers, M. Am. Soc. C.E. The plans and specifications were drawn by the author, and the work was performed under his supervision.

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ALL SAINTS CHAPEL, TRINITY CHURCH

This Chapel, at the Northwest Corner of the Church, Is Not a Part of the Original Structure

A Portable Hydraulic Laboratory

The Development of an Ingenious Device for Demonstrating Flow

By SCOTT B. LILLY

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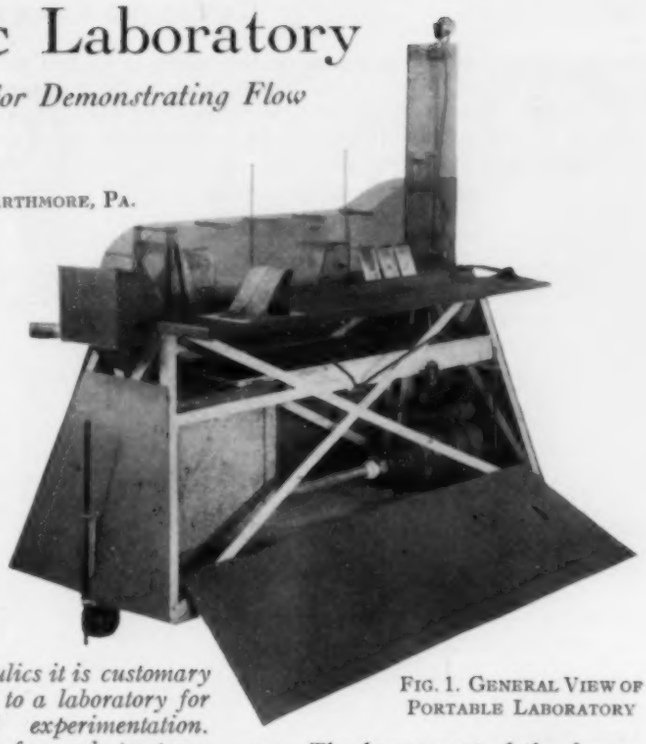


FIG. 1. GENERAL VIEW OF PORTABLE LABORATORY

IN teaching hydraulics it is customary to bring students to a laboratory for demonstration and experimentation. But a room suitable for such purposes was not available at Swarthmore College. Would it be necessary, then, to continue the earlier method of teaching without apparatus? By no means, said Professor Lilly—just bring the laboratory to the student! And this actually has been done by devising a self-contained unit which will permit water to be observed flowing through a variety of orifices and over a number of different types of weirs —the whole mounted on casters and capable of being moved about from one classroom to another. The following article, telling how the portable hydraulic laboratory is constructed, the method of operating it, and the purposes it serves, will be found of unusual interest.

AMONG the models exhibited at the Cornell meeting of the Society for the Promotion of Engineering Education, held at Ithaca, N.Y., June 19–23, 1934, was a celluloid flume, which, when placed so that it discharged into a sink, could be used to show certain hydraulic phenomena. I believe that it was part of the Iowa State exhibit, but the instructor who furnished it said that the idea was not original with him, and that he had seen something like it in another school. When we decided to build apparatus of somewhat similar type at Swarthmore, we immediately ran into difficulties, as there were no sinks in any of our classrooms. We felt that half the benefit of such a device would be lost if the students had to go into the hydraulic laboratory to see it, and so we planned at first to install a sink in one of the larger lecture rooms. But this would detract from the room's appearance, and an estimate of cost showed that it would be cheaper to build a self-contained unit, using a centrifugal pump and a tank, than to alter a lecture room. Furthermore, such apparatus would be movable and could be used in any classroom without affecting the usefulness of the room for other purposes.

CONSTRUCTION OF PORTABLE LABORATORY

Our plans, as finally developed, provided a tower at one end so that the apparatus could be used for demonstrating flow through orifices as well as through weirs. We bought the thickest celluloid we could find to minimize warping. Since the apparatus was to be moved about from one room to another, it had to be unusually tight and strong. Accordingly, the bottom was built up of two thicknesses of celluloid, with the lower sheet enough wider than the upper to be flush with the sides. A solid base seemed desirable, and a 2-in. plank was used for this purpose. The finished flume is 5 in. wide and the tower is 5 in. square. The top of the tower is 30 in. above the bottom of the flume, and the sides of the flume are $8\frac{1}{2}$ in. high and 50 in. long. A general view of the apparatus is shown in Fig. 1.

The framework for the plank base of the flume consists of angles and strap iron with three shelves or platforms. The lower platform carries the pump and tank. The first tank installed was found to be too small. When the flume and the tower were full of water, the level in the tank was so low that the pump did not function properly. With the present arrangement, the water is by-passed to the tank, as shown in Fig. 2, so that the flow can be throttled down as low as desired and still permit the pump to run smoothly. The fixed shelf directly above the pump is used for storing the movable parts of the apparatus. The third shelf is attached to the flume. This shelf can be raised and lowered and has proved to be very convenient when the apparatus is in use. The lower part of the framework is enclosed with fiber board, painted gray.

A small distributor, shown in Fig. 3, covers the opening of the inlet pipe in the tower. This device, which looks like an umbrella, was designed by George Bourdelais, our superintendent of shops, and contributes much to the success of the laboratory, particularly in the study of flow through orifices. The four openings in it are so arranged that whatever water flows through them passes downward along the upper surface of the distributor to meet the remainder of the flow coming up from below around the under surface. The impact resulting from the interaction of these two streams frees the water in the tower from turbulence to a marked degree.

There are two openings in the tower. The higher, about 12 in. above the bottom, consists of a hole in the celluloid 2 in. in diameter. Around three sides of the hole are slots in which thin copper plates can be inserted. Of course, orifices of any desired shape or size can be cut in these plates. We use almost exclusively three orifices, consisting of a $\frac{1}{2}$-in. round opening, a $\frac{1}{2}$-in. square opening, and one in the shape of an equilateral triangle with an altitude of $\frac{1}{2}$ in. The plates for these and for one additional orifice, a smaller round one, may be seen in Fig. 1. The centers of the orifices coincide with the center of the 2-in. circular hole previously mentioned.

At the very bottom of the tower, as shown in Fig. 2, is an orifice 2 in. square, in front of which is a thin vertical gate raised and lowered by a rack and pinion. The pinion is mounted on the shaft with a large knurled head and a graduated sleeve, so that the gate can be set accurately at any height. With this adjustment, it is possible to maintain the head in the tower at any desired height, and thus to keep a fixed head on any orifice.

In working with the portable laboratory the demonstrator occasionally found it easy to become so absorbed

in the operation of the flume or the weirs as to fail to notice the water rising in the tower. To guard against an overflow, there is a mercury switch at the top of the tower, operated by a float, which stops the pump. An outlet is provided in the copper basin into which the flume discharges, to facilitate emptying the tank.

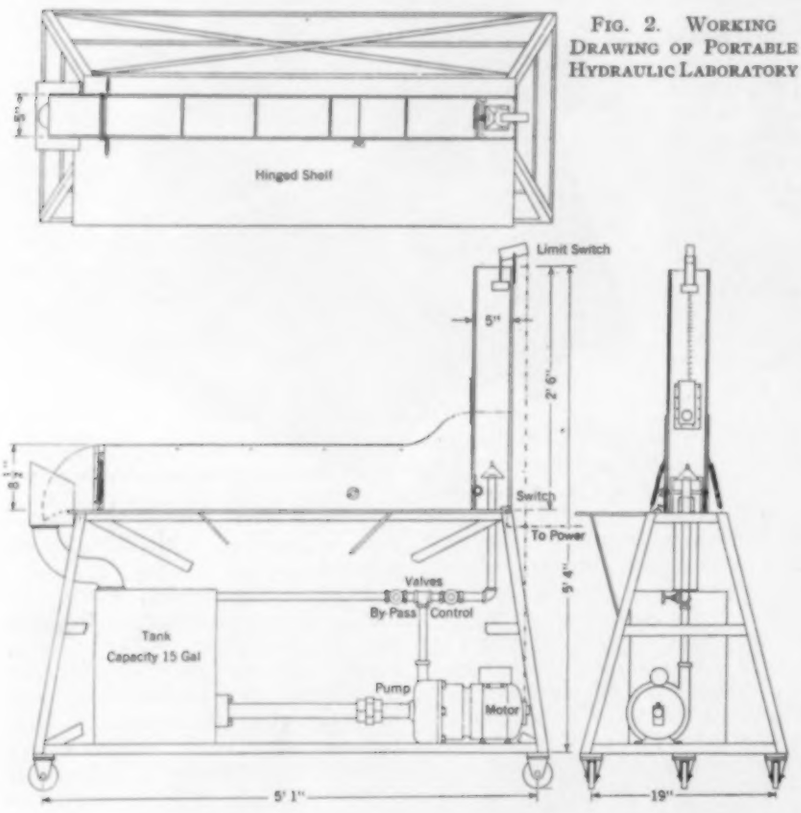


FIG. 2. WORKING DRAWING OF PORTABLE HYDRAULIC LABORATORY

When the opening into the tank is stopped, the pump will quickly unwater the apparatus. Stopcocks are provided near the pump to drain water that cannot be pumped out.

For mobility, the framework is mounted upon three ball-bearing castors with wheels 4 in. in diameter. There are also three threaded rods which can be used for leveling the apparatus or for giving the flume a grade when that seems desirable.

A fixture with slots, similar to that on the upper orifice in the tower, is used at the end of the flume. This will take copper sheets in which weirs of various forms have been cut. In Fig. 4 this fixture, containing the rectangular-notched weir, can be seen in operation. We have so far confined ourselves to two such weirs, a rectangular notch and a right-angled V-notch.

A suppressed weir, a broad-crested weir, or a model of the spillway of a dam can be inserted in the flume about one-third of the way from the tower to the outlet. These models are held in position by a rod passing through the walls of the flume about 2 in. above the bottom. In Fig. 5 may be seen a broad-crested weir in place.

USES OF THE PORTABLE LABORATORY

So much for the construction of the laboratory. The next question is: What can be done with it? It never has been our intention to stress the quantitative side of the apparatus. We wanted to be able to show what was meant by the various terms, and to simplify the work so that the ground could be covered in a quicker and more effective manner.

Considering first the orifice—the vena contracta, the path of the jet, and the inversion of the jet can be demonstrated easily (Figs. 6 and 7). The coefficient of contraction can be determined by measurement, with the usual amount of difficulty attending that operation. The coefficient of velocity can be determined from the path of the jet, the coordinates of a point on the jet being easily measured.

The weirs at the end of the flume show the shape of the nappe, and after the student has watched the form change with the changing head, he has a clear idea of why it is necessary to use a factor to allow for the reduction of the width of the nappe as the head increases. With the suppressed weir mounted in the channel, it is easy to demonstrate what happens when a weir is improperly ventilated. The student can see the effects of the vacuum forming behind the nappe, can watch the water cling to the face of the weir over a part of the width and then spring clear, and can observe the general uncertainty of the flow under such conditions.

The model of the broad-crested weir is especially interesting. The line of the surface of the water, as observed through the sides of the flume (Fig. 5), conveys a much more vivid picture than a line drawing in a book. The student can see the first drop followed by the gradual change in depth as the velocity increases. The standing waves below a submerged weir can be obtained with little difficulty. The facilities for demonstrating these typical hydraulic problems at the time they are studied in the text is a great aid to teacher and student alike.

A model of the spillway of the Conowingo Dam is ideal for getting a high velocity at the foot of the slope when the hydraulic jump is under consideration. The position of the jump can be changed with the head and with the depth of the water below the spillway. This depth is controlled by raising or lowering the fixture which carries the weirs at the end of the flume.

Time problems can be arranged. The time necessary to lower the level of the water in the tower a certain distance or the time required to lower the water level in the flume can be determined. Hook gages are installed in the flume for this purpose and a gage is etched on a side of the tower with the zero corresponding with the center of the orifice in the thin copper plate. Another advantage of the time problem as a means of instruction is that, in addition to the effects of motion in the body of water being emptied, the student can see that the nappe clings to the face of the thin plate when the head is low. This will impress upon him the fact that he should never attempt to integrate for the time when his lower limit is the head on the bottom of a weir. This clinging can be observed even with the V-notched weir.

These are only a few of the many things that can be shown with this device. It is so simple and so easily controlled that the student can learn a great deal by watching the effect of changing the flow. Turbulent flow, once seen, will always be remembered, and the difficulties in measuring the head with a hook gage without a stilling chamber, or of calipering a jet, have a greater significance after they have been experienced. We feel our $350 investment has yielded a rich return.

FIG. 4. END CONTRACTIONS FOR A RECTANGULAR-NOTCHED WEIR
By Means of This Device Contractions Can Be Seen and Measured

FIG. 5. A BROAD-CRESTED WEIR SHOWING NON-UNIFORM FLOW
This Form of Weir Is Used to Illustrate the Drop-Down Curve

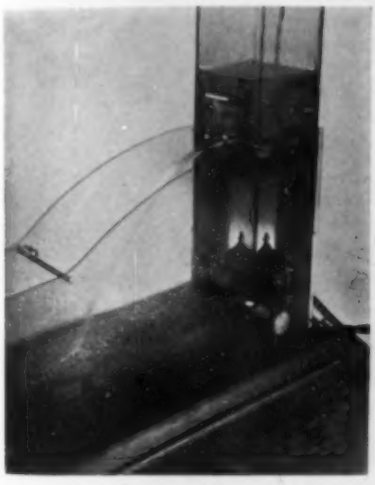


FIG. 6. FLOW THROUGH A STANDARD CIRCULAR ORIFICE
The Vena Contracta C_V Can Be Determined from the Jet

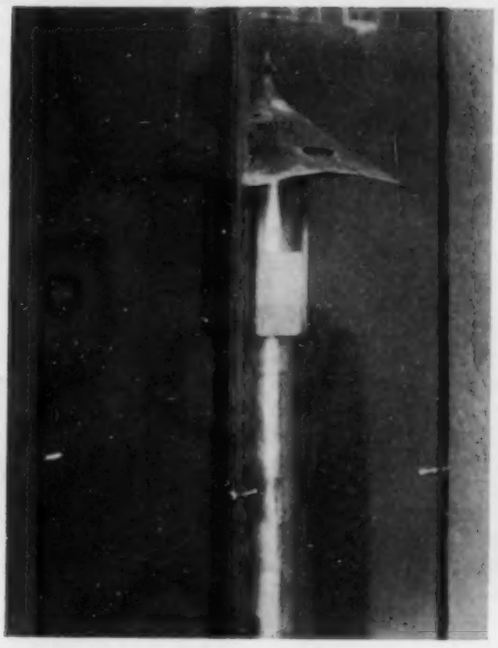


FIG. 3. A CLOSE-UP OF THE STILLING DEVICE, SHOWING SLOTS IN UMBRELLA COVER

FIG. 7. THE TRIANGULAR ORIFICE SHOWS THE INVERSION OF THE JET
The Pump Is Maintaining a Constant Head Without Turbulence

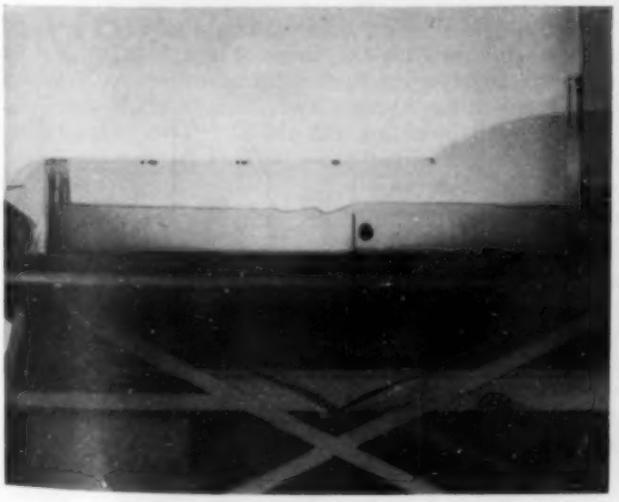


FIG. 8. THE STANDING WAVE BELOW A SUBMERGED WEIR
The Head Can Be Adjusted Within Narrow Limits by the Valve on the Pump. The By-Pass Valve Prevents Churning

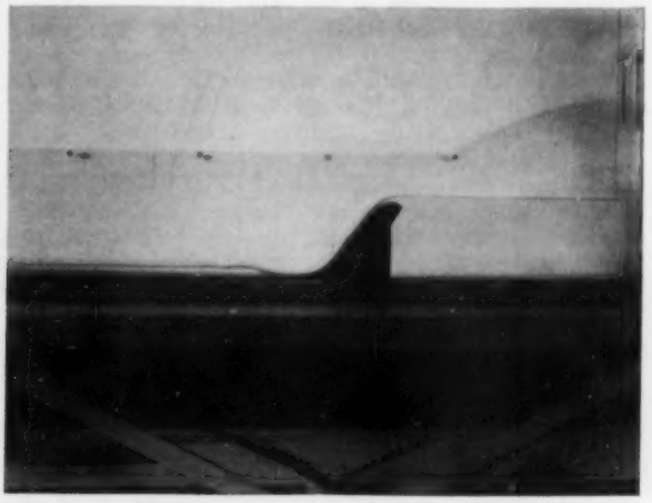


FIG. 9. A MODEL OF THE SPILLWAY, CONOWINGO DAM
This Is an Ideal Device for Showing the Hydraulic Jump. Gravel Glued to a Metal Plate Provides a Removable Rough Channel

Traffic Regulation for 38th Street Tunnel

Proposed Plan Will Avoid Local Delays to New York's Through Traffic

By Anders Bull

Member American Society of Civil Engineers
Assistant Engineer, Board of Transportation, New York, N.Y.

CONSTRUCTION of the first tube in New York City's second underground vehicular crossing of the Hudson—the Midtown Hudson Tunnel, connecting the Borough of Manhattan with Weehawken, N.J.—is steadily progressing, and is scheduled for completion in 1938. A similar tunnel is planned under the East River, giving access to the Borough of Queens and the 1939 World's Fair grounds, and the two are scheduled ultimately to be connected by tubes under 37th and 38th streets, Manhattan. A plan for regulating traffic in this intricate three-link tunnel system is here presented by Mr. Bull. Although under this plan the services of an experienced dispatcher will be required to control operations in general, the mechanism of the control system is automatic. By the use of electro-mechanical car counters, and of signal control and traffic indicating devices, it will be possible for cars entering the tunnel at intermediate junction points to replace outgoing cars without slowing up the through traffic, insuring in this way maximum efficiency in the operation of the tunnel.

AMONG the vehicular tunnels planned for the Metropolitan District of New York, the 3-link system connecting Weehawken, N.J., with the Borough of Queens on Long Island is of special interest from the point of view of traffic regulation. Designed as a twin tunnel throughout, this system, when complete, will constitute two independent two-lane roadways 21 to 21½ ft wide, one for east-bound and the other for west-bound traffic, offering unobstructed passage for a distance of 4.2 miles, or 6.4 miles when the open-air feeders in New Jersey, Queens, and Brooklyn are included. At a speed of 20 miles per hr these distances may be covered in 15 min and 23 min, respectively. A plan of the entire system, the cost of which has been estimated at about 180 million dollars, is shown in Fig. 1.

The western link, comprising the Midtown Hudson Tunnel and extending from Homestead, N.J., over Weehawken to the West Side, Manhattan, is in course of construction under the direction of the Port of New York Authority. The south tube, which for initial operation will accommodate both east- and west-bound traffic, was holed through last August and is scheduled to be in operation by January 1938. The eastern link, comprising a tunnel under the East River and extending from the East Side, Manhattan, over Queens to Brooklyn, is under the direction of the New York City Tunnel Authority. The work on this part has not yet reached the design stage.

So far no steps have been taken toward starting work on the crosstown link, although it will be urgently needed when the new river tunnels are put in operation. Without additional facilities to take care of the increased traffic, it is likely that inconveniences will arise of a more serious nature than those the tunnels are intended to relieve.

Operation of Tunnel Presents Traffic Problem

The operation of the three links presents an intricate traffic problem owing to the fact that there will be several junction points where traffic will enter as well as leave the tunnels. How to make the ingoing traffic merge with through traffic without mutual interference is a question that assumes special significance at the East Side, Manhattan, junction, where the end of the river section is far below the surface of the ground.

In planning the crosstown link, much thought was given to the solution of this problem, which was discussed by the late John R. Slattery, M. Am. Soc. C.E., in an article published in Civil Engineering for October 1931. Two main alternatives were considered—whether to merge the two streams of traffic at a "mixing plaza" located above ground or at one located underground. The first alternative was given preference, principally because it was feared that the unavoidable traffic holdups attending an underground mixing might produce such unfavorable reactions, both psychological and physical, on the part of the motorists as to jeopardize the economy of the entire undertaking. It was considered of vital importance that motorists entering the tunnels at any point should be permitted to complete the tunnel passage without interruption and with the least possible delay.

In Fig. 2 appears a plaster model of the arrangement proposed in the first alternative for carrying all the tunnel traffic to the surface at the East Side, Manhattan, junction. Because of the depth below the East River, this plan contemplates elliptical spiral loops having a maximum grade of 4 per cent, a minimum radius of 100 ft, and diameters of about 1,400 ft, measured along the major axes. While still in the loops, through traffic will be separated from local outgoing traffic and led to the mixing plaza at Second Avenue and 38th Street, there to be merged with local ingoing traffic. The loops will in-

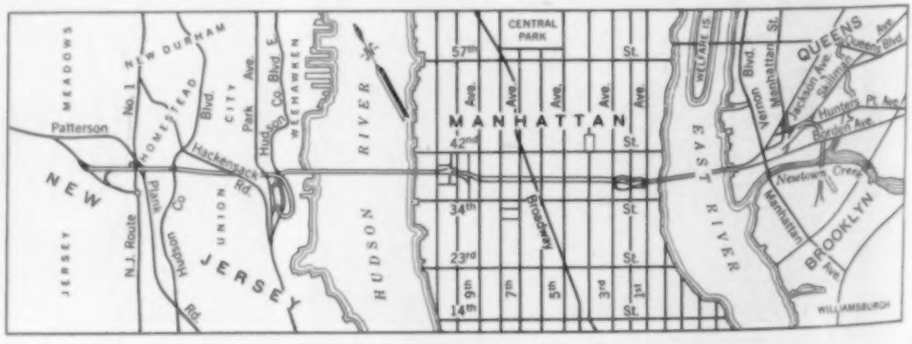


Fig. 1. Location Plan for the 38th Street Tunnel, New York, N.Y.
This Proposed Vehicular Tunnel Includes Three Principal Links—The Midtown Hudson Tunnel, the Crosstown Tunnel, and the East River Tunnel

crease the distance of travel for through traffic by 3,100 ft and involve a loss of time of 1.7 min, assuming a speed of 20 miles per hr.

A NEW SOLUTION IS PROPOSED

A new solution of the traffic problem has recently been worked out by the writer, with a view toward combining the desirable features of both the earlier plans. The salient characteristics of this latest plan are as follows:

1. Through traffic will not be brought to the surface at the East Side, Manhattan, junction, but will proceed by an undeflected route and easy grades to the chosen exits.
2. Incoming local traffic will enter the through lanes at a suitable distance, say 2,400 ft, beyond (in the direction of travel) the point at which outgoing traffic will leave the through lanes.
3. All traffic will be let into the tunnels in batches, the number of cars in each batch at any time depending upon the relative amounts of traffic at the several plazas.
4. The leading car in each batch will be kept moving at a definite speed by means of traffic lights placed at

A BUSY DAY AT THE MANHATTAN ENTRANCE TO HOLLAND TUNNEL

frequent intervals. When some of the cars leave the through lane at an exit point, the remaining cars will be impelled to close up, those in the rear temporarily increasing their speed, so that when passing the next entrance point they will again have the normal speed and spacing.

5. The regulating of traffic referred to in Paragraphs 3 and 4 will be accomplished by means of simple signal equipment, operating automatically under the supervision of a dispatcher, who by distant control will change the size of the batches from time to time to suit traffic conditions.

The proposed plan may be used with equal advantage for one or several junctions, either above or below ground. However, in order to simplify matters the operation of the plan will be explained for one junction only, that at the East Side plaza.

A tentative layout of tunnel approaches suitable for the proposed plan is shown in Fig. 3. The locations assumed for the entrance and exit plazas are the same as in a plan worked out by the Board of Transportation on the assumption that the tunnel across Manhattan would not be built. These locations may not, perhaps, be the best with the crosstown tunnel in operation, but will serve for illustrative purposes. Level or downhill grades have been provided between exit and entrance points to speed up the rear cars.

The signal system is the outstanding feature of the proposed plan, which is based on the use of car counters,

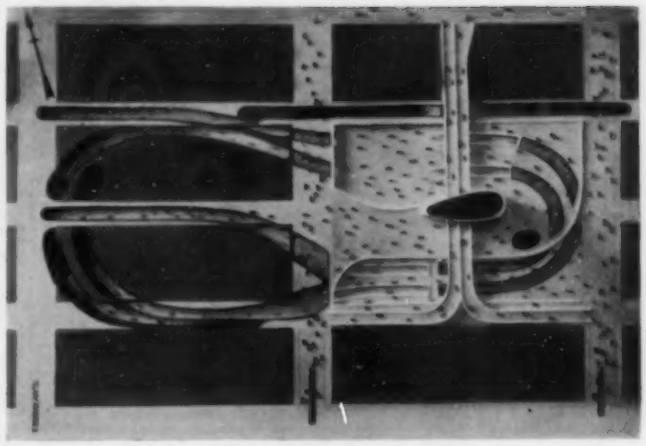


FIG. 2. ORIGINAL PLAN FOR EAST SIDE, MANHATTAN, JUNCTION
Model Illustrating Arrangement for Bringing All Traffic to the Surface at Junction Points

signal lights, controls, and traffic indicators. Devices for counting cars will be built into the driveways at critical points. The counters may be of the photoelectric type, responding to the interception of a light beam by the cars, or may consist of a rocker plate operated by the combined action of weight and backward "kick" from the driving wheels. The resulting motion causes contact to be made for the transmission of an electrical impulse every time a driving axle passes over the counter. Since in all but exceptional cases a vehicle has only one driving axle, only one impulse is ordinarily transmitted for each car.

Counters will be installed in the exit lanes as well as in the through lanes just beyond the points where the exit lanes turn off. They will also be placed in entrance lanes at portals. These will be referred to as "through counters," "exit counters," and "entrance counters."

Signal lights will be needed in entrance lanes and in all but the last part of through lanes. For effective control these lights will be placed at frequent intervals, say 150 ft apart, so as to create the impression of motion. As it is important to keep traffic in the tunnels moving at all times, the colors green and yellow will be used for inside traffic lights. A red light is too closely associated with stopping, while the yellow light imparts only a warning. The meaning of the yellow light will be impressed upon motorists by prominent illuminated signs reading "Never pass a yellow light." Two yellow signal lights will be "moving," one at least 150 ft ahead of the leading car and the other abreast of it. The car will not be permitted to pass either light.

In through lanes the speed of the yellow signals will be fixed at, say, 30 ft per sec (about 20 miles per hr) and their operation will be controlled by a device similar to that shown in Fig. 4 (*a*). This mechanism consists of a holder, *A*, rotating at the rate of one revolution in 100 sec, and fitted with two brushes, *b*, *b*, which slide over the contact segments *S*. Assuming the distance between the leading cars in consecutive batches to be 3,000 ft, there would be 3,000 divided by 150, or 20 signal lights required per batch, 2 yellow and 18 green, for the operation of which 20 segments would be needed. Counting from the portal, the first segment would be connected to lights Nos. 1, 21, and 41, the next segment to Nos. 2, 22, and 42, and so on. As soon as contact is made between the front brush and a segment, the lights connected to that segment would change from green to yellow, remaining yellow until the rear brush left the segment.

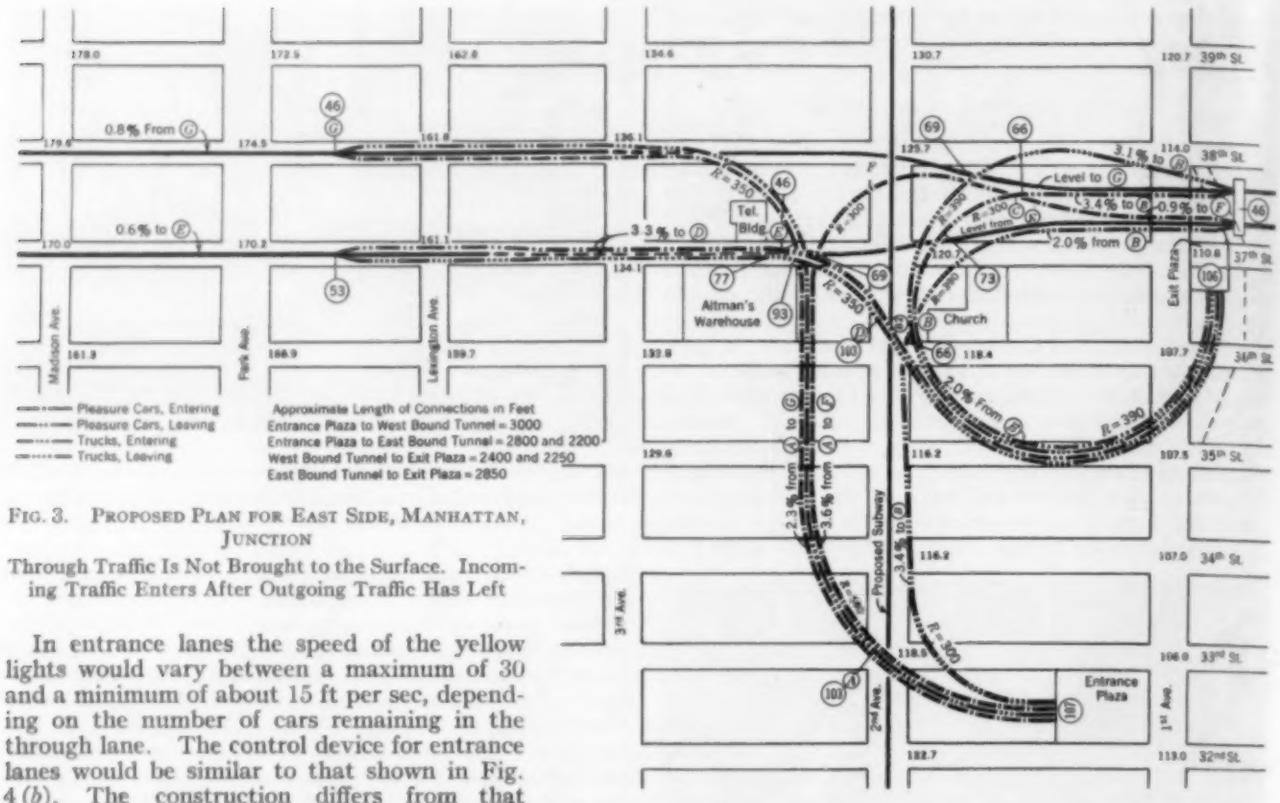


FIG. 3. PROPOSED PLAN FOR EAST SIDE, MANHATTAN, JUNCTION

Through Traffic Is Not Brought to the Surface. Incoming Traffic Enters After Outgoing Traffic Has Left

In entrance lanes the speed of the yellow lights would vary between a maximum of 30 and a minimum of about 15 ft per sec, depending on the number of cars remaining in the through lane. The control device for entrance lanes would be similar to that shown in Fig. 4 (*b*). The construction differs from that shown in Fig. 4 (*a*) in that the contact segments S' may be independently rotated, being mounted on the ratchet disk R. Although clamped to the shaft P by means of a friction washer, the disk is prevented from rotating with the brush holder by the ratchet r, which engages one of the teeth, t. The number of the segments S' is determined by the length of the entrance lane, one segment being required for each signal light. With the holder A' rotating at the rate of one revolution in 200 sec, the 17 segments shown would be swept by the brush in 85 sec. When, however, the magnet M is energized by an impulse from the through counter, the ratchet r is withdrawn for an instant, permitting the disk to move forward one tooth. With 50 teeth on one-half the periphery, each forward step of the disk would increase by 2 sec the time required for the brushes to sweep the segments, and the cars in the entrance lane would be delayed an equal time. When the rear brush leaves the last segment, the friction washer (not shown) is automatically released, and the disk is returned to its starting position by the coiled spring C. Two of these controls will be required for each entrance lane, operating alternately.

PERSPECTIVE OF MIDTOWN HUDSON TUNNEL, WITH WEST SIDE, MANHATTAN, JUNCTION IN FOREGROUND

An indicator will be placed at each point where traffic is admitted to the tunnels to supply the guard stationed at that point with the information necessary for directing the traffic. Its main features are shown in Fig. 4 (*c*). It consists of a dial of, say, 2 ft in diameter mounted on a post, P, with green and red traffic lights, G and R, above. The hand H will be set automatically from the dispatcher's office immediately before the admission of each batch, to indicate the number of cars to be admitted, after which the green light will be illuminated. At terminal plazas the movement of the hand will be controlled by impulses from the entrance counter in such a way that it will move backward one place for each car entering the tunnel, finally pointing to zero. At junction plazas the movement of the hand will be under the additional control of impulses from the exit counter, each such impulse causing the hand to move forward one place, so that an additional car may be admitted for each car leaving the through lane at the exit point.

If for any reason the full number of cars indicated on the dial have not entered the tunnel within a fixed time limit, say 80 sec, the hand will be automatically returned to zero as the red light appears on top of the dial, signifying that ingoing traffic must stop. The red light will stay on for, say, 20 sec, and then ingoing traffic will be resumed.

HOW THE SIGNAL SYSTEM WILL OPERATE

The operation of the proposed plan is best explained by a few examples, for which it will suffice to consider a single line of traffic moving in one direction. The numerical figures used in these examples have been arbitrarily chosen, no data being available on which to base an estimate. This is of no consequence, however, as adjustments are easily made to suit any other condition.

EXCAVATING FOR WEST SIDE, MANHATTAN, JUNCTION AT WEST 58TH STREET AND TENTH AVENUE

In Fig. 5 (*a*) the parallel lines *A*-*D* represent a through lane for east-bound traffic, the widened part at *A* indicating the entrance plaza at West Side, Manhattan, those at *B* and *C*, respectively, the East Side entrance and exit plazas, which are connected to the through lane by lanes *B*-*F* and *C*-*E*.

Let us assume that during normal capacity traffic, cars are admitted to the tunnel at *A* in batches of 40 with an average spacing of 60 ft between cars. These cars will be referred to as *A*-cars. The hand on the indicator at *A* accordingly will move forward to 40 just before the green light appears on top of the dial. Vacant spaces of 660 ft will be left between the batches, making the distance between the leading cars in consecutive batches 3,000 ft. To facilitate measurements, vertical lines have been drawn across the diagram at intervals of 300 ft, the distance traveled in 10 sec at 30 ft per sec.

The signals for the cars entering at *B* (*B*-cars) will be synchronized with the signals in the through lane so that the yellow lights at Points *1* and *2* will light up simultaneously. The green light will appear above the dial at *B* after the hand has moved forward to the number 5. Five *B*-cars accordingly will be admitted. These five cars, in the event that none of the 40 *A*-cars leave at *E*, will fit into the 660-ft space left between the batches and still leave safety margins of 210 ft front and rear.

Assuming that 20 cars of the batch of 40 normally leave by the exit lane at *E*, the gaps between the 20 *A*-cars remaining will be closed up as they move on toward *F*, the last car increasing its speed to about 45 ft per sec (30 miles per hr), so that, when it arrives at *F*, the spacing of the *A*-cars will have been reduced again to 60 ft.

In passing the through counter at *E*, these 20 cars will have caused 20 electric impulses to be transmitted to the signal control at *B*, moving the ratchet disk forward by 20 teeth. The leading *B*-car will thereby have been delayed 40 sec, so that it will arrive at *F* in 85 plus 40, or 125 sec, after the leading *A*-car has passed *E*. During this time the leading *A*-car will have moved 3,750 ft (125 × 30), or from *E* to *3*, and the last *A*-car of the batch will be 60 ft beyond *4*, or 210 ft ahead of the leading *B*-car, the distance between *4* and *F* being 150 ft.

Meanwhile the 20 *A*-cars leaving the through lane, in passing the exit counter at *E*, have caused 20 impulses to be transmitted to the traffic indicator at *B*, moving the hand forward 20 places. Therefore 20 plus 5, or 25 *B*-cars will be admitted, filling the gap between the batches of *A*-cars, except for the safety margins of 210 ft in front and rear.

Drivers who have been too slow in closing up the gaps while moving from *E* to *F* will be stopped by the guard stationed at *F* in order to prevent interference with incoming traffic. Such occasional stragglers will be detained for a period of about 60 sec, until overtaken by the leading car in the next batch, of which they will now form the advance guard.

SOME ILLUSTRATIVE TRAFFIC PROBLEMS

To show how the proposed plan will work in cases of extreme deviation from the normal schedule, let us next assume that:

1. All the *A*-cars in a batch continue in the through lane, none leaving at *E*, Fig. 5 (*b*). In this case only the 5 cars registered as the green dial light appears will be admitted at *B*, since no impulses will have been sent from the exit counter. Since 40 impulses have been sent from the through counter to the signal control at *B*, the ratchet disk will advance 40 teeth, delaying the leading *B*-car 80 sec and causing it to arrive at *F* in 85 plus 80, or 165 sec after the leading *A*-car has passed *E*. During this time the leading *A*-car will have moved 4,950 ft (165 × 30) to 5, and the last *A*-car of the batch will again be 60 ft beyond 4, or 210 ft ahead of the leading *B*-car.

2. All the *A*-cars in a batch will leave the through lane at *E* (Fig. 5 (*c*)). No impulses in this case will be sent from the through counter at *E;* the leading *B*-car will not be slowed down, but will arrive at *F* at the time when the leading *A*-car, had it remained in the through lane, would have been 60 ft beyond *4*. Since 40 impulses will have been sent from the exit counter, 5 plus 40, or 45 cars, may be admitted at *B*.

In the preceding examples, the hands of the traffic indicators at *A* and *B* were automatically set to the numbers

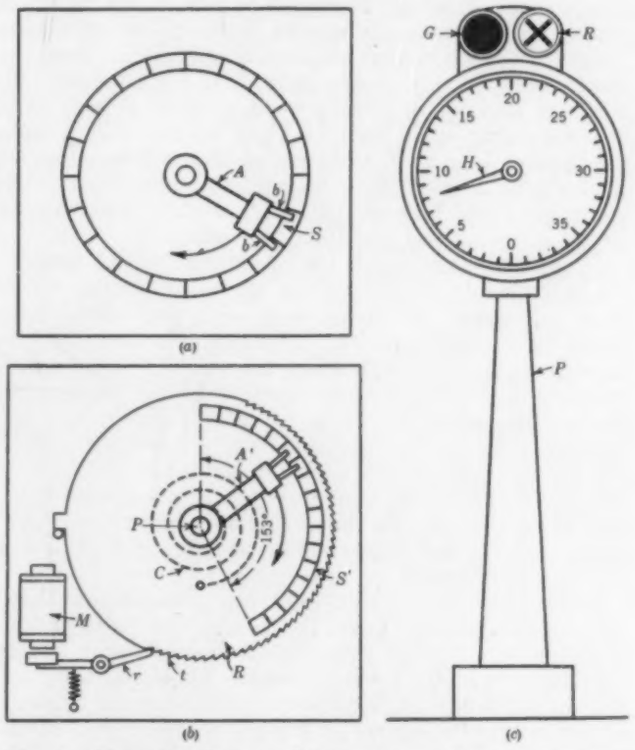


FIG. 4. PROPOSED SIGNAL CONTROLS AND TRAFFIC INDICATOR
(*a*) Device for Controlling Yellow Signals in Through Lanes
(*b*) Device for Controlling Yellow Signals in Entrance Lanes
(*c*) Mechanism Used at Entrance Points for Indicating Automatically the Number of Cars to Be Admitted

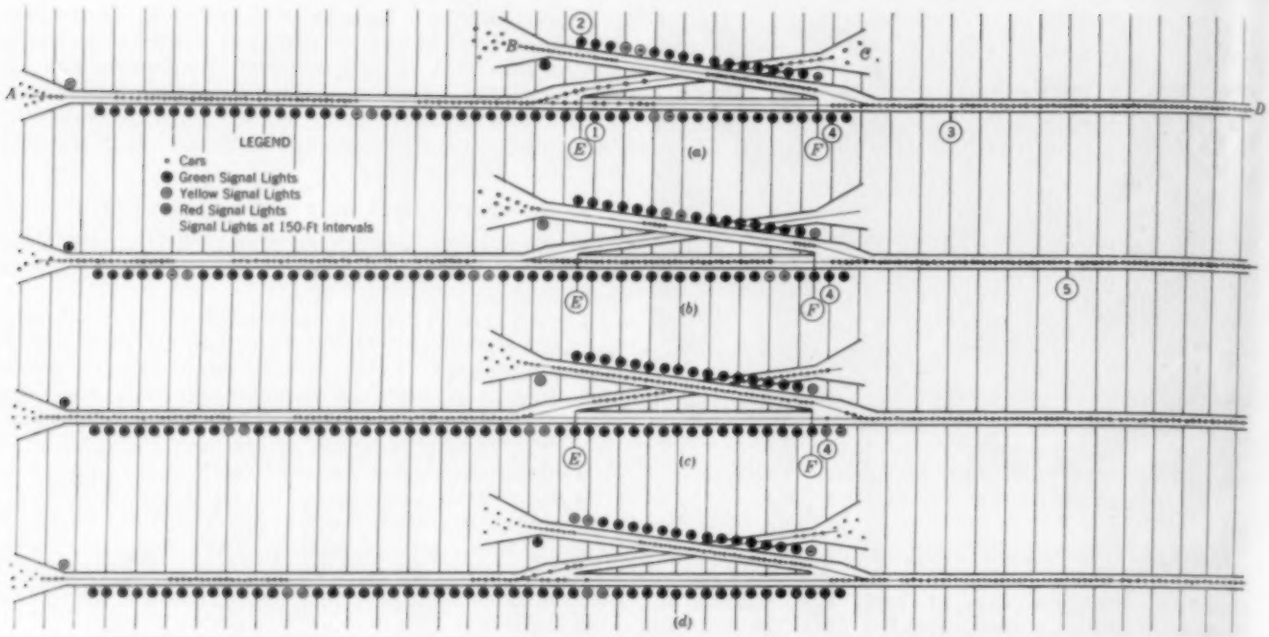


FIG. 5. DIAGRAMS ILLUSTRATING OPERATION OF SIGNAL SYSTEM FOR VARYING CONDITIONS OF TRAFFIC

(*a*) Normal Schedule—40 *A*-Cars Admitted; 20 *A*-Cars Leaving at *E*; 25 *B*-Cars Entering at *F*. (*b*) Extreme Condition—40 *A*-Cars Admitted; No *A*-Cars Leaving at *E*; 5 *B*-Cars Entering at *F*. (*c*) Extreme Condition—40 *A*-Cars Admitted; All *A*-Cars Leaving at *E*; 45 *B*-Cars Entering at *F*. (*d*) Heavy Traffic at *B*, Light Traffic at *A*—20 *A*-Cars Admitted; 10 *A*-Cars Leaving at *E*; 35 *B*-Cars Entering at *F*

40 and 5, respectively, prior to the appearance of the green light above the dial. With one-half of the *A*-cars leaving the through lane at *E*, batches of 40 and 25 cars, respectively, may be admitted every 100 sec at *A* and *B*.

Suppose that this adjustment at some other time should result in an accumulation of cars at the East Side entrance plaza and subcapacity traffic in the crosstown tunnel. The dispatcher, when advised of this situation, would readjust the traffic indicators by changing the numbers initially registered to, say, 20 at *A* and 25 at *B*. Assuming again that one-half of the *A*-cars leave the through lane at *E*, the number that will be admitted at *B* will be 25 plus 10, or 35 per batch, Fig. 5 (*d*). The following Table I shows the effect of such readjustment on the congestion at the East Side plaza.

If, on the other hand, the crosstown tunnel were already loaded to capacity while there was a rush at the East Side plaza, increasing congestion and traffic delay would be bound to result. The best that can be done in such a case is to apportion the waiting time equally between the cars at the two entrance plazas by changing the adjustment of the traffic indicators. In no case will ingoing traffic at the junction come to a complete standstill for any considerable length of time, and unavoidable periods of delay will probably prove less exasperating than they would if the through traffic were taken to the surface and given right-of-way within sight of a line of waiting motorists.

In the examples given, only one intermediate junction was assumed. It will be realized that with several junctions, as in the three-link tunnel system, traffic regulation becomes a very complex problem, the handling of which cannot, in conformity with present practice, be left to the judgment of the guards stationed at the several plazas. No tunnel having been built that might serve as a pattern in this respect, new methods must be developed in order that the public may be served to the best advantage and maximum economy of operation attained.

TABLE I. COMPARISON OF TIME LOST, WITH AND WITHOUT TRAFFIC READJUSTMENT

Time Elapsed	With Readjustment				Without Readjustment				
	Number of Cars		Time Lost		Number of Cars			Time Lost	
Minutes	Entering	Accumulated	Minutes, Max.	Car-Minutes	Arriving	Entering	Accumulated	Minutes, Max.	Car-Minutes
0	..	..	...	...	25	25	0	0	0
	..	..	...	...	30	25	5	1.7	8
	..	..	...	...	35	25	15	1.7	33
5	..	..	...	...	40	25	30	3.3	91
	..	..	...	...	45	25	50	3.3	208
	35	65	3.3	325	50	25	75	5.0	417
10	35	80	5.0	500	50	25	100	6.7	708
	35	90	5.0	683	45	25	120	8.3	1,042
	35	95	5.0	858	40	25	135	10.0	1,383
15	35	95	5.0	1,017	35	25	145	10.0	1,708
	35	90	5.0	1,150	30	25	150	10.0	2,000
	35	85	5.0	1,275	30	25	155	11.7	2,308
20	35	75	5.0	1,367	25	25	155	11.7	2,567
	35	65	3.3	1,450	25	25	155	11.7	2,825
	35	55	3.3	1,525	25	25	155	11.7	3,083
25	35	40	3.3	1,567	20	25	150	10.0	3,283
	35	25	1.7	1,600	20	25	145	10.0	3,483
	35	10	1.7	1,617	20	25	140	10.0	3,675
30	35	0	0	1,617	20	25	135	10.0	3,858

The proposed plan relies on the principle of centralized control, with responsibility for proper regulation placed upon a dispatcher whose duty it will be to decide from the ever-changing picture presented by the traffic conditions in the tunnel system as a whole, what adjustments should be made from time to time. The task will call for skill and experience during periods of capacity traffic, while at other times less attention will be required, as the operation of the system will be more or less automatic.

Great Britain Tidies Her House

Social and Engineering Implications of a Stabilized Population

By DAVID C. WILLIAMS

BRIDGHAM FELLOW FROM THE UNIVERSITY OF OREGON TO COLUMBIA UNIVERSITY, NEW YORK, N.Y.

THE population of Great Britain and particularly of England has been increasing in recent years at a progressively slower rate, and seems likely to become stationary in the near future. Changing economic conditions, moreover, have resulted in the setting up of the first protective tariff in English history. It thus appears that Great Britain is now about to leave a period of expansion and to enter upon an era of conservation. As a Rhodes Scholar at Oxford for three years, Mr. Williams had an excellent opportunity to observe the effect of these changes upon English engineering and social planning activities. In the following article, abstracted from his remarks before the October 30, 1935, meeting of the Columbia University Student Chapter, he points out that in Great Britain the engineer's work is increasingly characterized by organization, planning, and rebuilding, with strict attention to matters of cost. It may also be that there is a message here for members of the profession in the United States, where the population is likely to attain a fixed figure in the not too distant future, according to recent predictions.

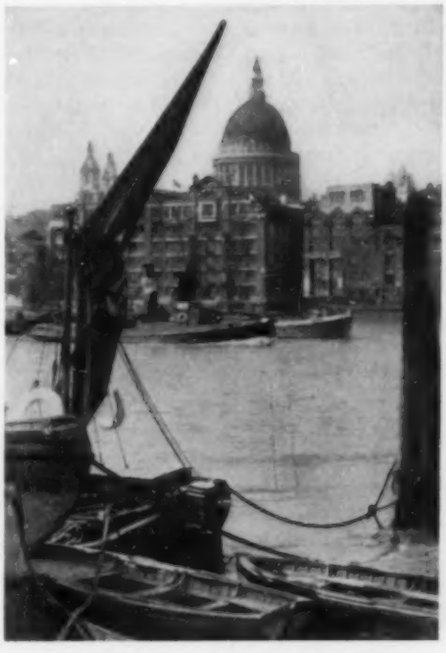
THE impression the average American tourist carries away after a visit to England is one of solidity, well-being, and permanence. He has spent most of his time in London and has probably made only short excursions to see the cathedrals of Winchester and Canterbury. In all his stay the beauties and the achievements of past ages have surrounded him. It is inevitable that he should think of England as an old and staid country, one that changes little as the years go by. Some doubts might have entered his mind if he had gone off the beaten tourist tracks, and had visited Wales or the north of England. In these regions, which provide the iron, coal, and textiles that once made England leader of the world's trade, he would have found hopelessness and despair lying as heavy as the omnipresent smoke and fog. He would have come to towns where from 30 to 60 per cent of the working population is unemployed, and where there is no hope of putting them to work again.

He probably would then have realized the truth—that England is at a crucial point in her history, standing on the threshold of a new era in which her task and position will be far different from what they have been in the past. That new order will have a far-reaching effect on the position of the English engineering profession and on the nature of the problems it will be called upon to solve. While these changes began years ago in the history of England and of the world, they became evident clearly and finally only in 1931, when England established a protective tariff. In America, where we are always tinkering with our tariffs, the importance of that step is likely to be underestimated. Under the previous policy of free and unrestricted trade, England had become merchant, manufacturer, and banker to the whole world. In 1931, however, she erected a wall between herself and the outside world and turned her attention inwards to see what sort of prosperity she could create for herself out of her own small land.

LIGHTER INDUSTRIES GO TO LONDON

The basic industries—coal, iron, textiles—had long been ailing, and unemployment in the towns that depended upon them had reached staggering figures. The tariff ended any possibility of a considerable future expansion. It began to be said—tentatively at first, but later definitely—that unemployment is a "permanent problem." At about this time the lighter luxury industries went into a mild boom. Prior to 1931 England had not bothered to make things like perfume and bathing suits, which the foreigner made better and cheaper. But now, under the protection of the tariff and the impetus of a strenuous "Buy British" campaign, modern factories sprang up like mushrooms.

But they did not go to Wales and to the north, where they were most urgently needed. The majority went to the south of England; and of these again the larger proportion to the outer ring of London. Some believe that this was an attempt to find cheap labor and to avoid the strongly unionized north. This may have been true; it is also true that London was the center of the market for luxury goods, and moreover, that continued depression in the north had created a community sentiment that was most unfavorable to new enterprise. With the increased demand for labor in the south, a steady migration began from the north, resulting in a long-continued and phenomenal growth of London while the other cities either grew slowly or stood still.



VISTA ON THAMES RIVER AT LONDON
St. Paul's Cathedral Appears in the Background

Before the political leaders perceived the new order, it had been foreshadowed by England's vital statistics. The birth rate had dropped steadily, and statisticians were beginning to consider the possibility of the population's becoming stationary in the near future and declining in the not too distant future. Meanwhile, although wide open spaces still existed in the Empire, immigration and emigration came practically to a standstill. Once the movement from the north to the south has ceased (and it can last only as long as the industrial readjustment which gives rise to it) the current of English life will flow into a still lake. The problems of the engineer and the statesman will be those of administering the restricted resources and environment of England in such a way as to afford

the greatest measure of content and happiness to its 45,000,000 people. Barring the possibility of foreign invasion, England now leaves an era of expansion and enters on an era of conservation and rebuilding.

The immediate problem is the growth of London; the ultimate problem social planning. From this point on, leaving aside all the economic and social aspects, I shall indicate the significance of these problems to the engineering profession, and the steps which have been taken to solve them.

PROGRESS IN CITY PLANNING AND TRAFFIC CONTROL

Even in the past century the growth of London had become a cause of great concern. Cobden, watching it swallow up his beloved countryside, called it "that monstrous wen." There was a belief, common enough at the time but a little shopworn now, that the free and unlimited competition of selfish and unselfish men could result in something besides a free and unlimited muddle. Forgotten or discarded were the plans of architects like Christopher Wren for the building of London, and row upon row of dreary brick houses spread out into the suburbs. Around 1900 there were evidences of a change in the point of view. The Thames Conservancy, which looks after the interests of the Thames watershed, the Port of London Authority, governing the miles of docks and waterways in the world's most cosmopolitan harbor, and the London County Council, under which London's countless towns and boroughs are unified, were bodies created about that time to handle the common regional problems of the metropolitan area. But over these authorities there is one super-regional authority, namely, Parliament. While it may be an exaggeration to say that, in the strongly centralized English government, not a sparrow falls without the knowledge and consent of some bureaucrat at Whitehall, it is not a great exaggeration.

There is even a minister of transport in the cabinet to deal with traffic problems. A Mr. Hore-Belisha occupies that post; he began with the name of Horeb-Elisha, but the examination schools at Oxford made a fortunate misspelling, and he adopted it. Being a rising young man with a career to make, he has been very active, and the last few years have witnessed a great deal of legislation dealing or attempting to deal with London. Perhaps Mr. Hore-Belisha's most widely publicized work has been that in connection with the London traffic problem. How serious that problem is appears from the figures. In 1932 there were 1,326 deaths from traffic accidents in London, while in New York, with a population greater by 2,000,000 and a much larger number of automobiles, there were only 1,298. The measures taken have included tests for drivers' licenses, installation of new and ingenious (though sometimes bewildering) signals for traffic regulation, and the establishment of a speed limit of 30 miles per hour in the "built-up areas," which are distinctly marked. Last and most famous are the so-called "Belisha beacons." These consist of thousands of orange globes set on black and white posts, at every one of which the conscientious motorist is expected to stop. What their benefits have been, apart from the additions they have made to the national repertoire of music hall songs and jokes, is still an open question; although Eddie Cantor, when he recently passed through London, was called up before a battery of news cameras to express his interest in and approval of them to the Minister of Transport.

A VIEW IN RURAL ENGLAND—ALLENFORD BRIDGE AT SOMERSET

BY-PASSES CONSTRUCTED AND CITY TRANSPORTATION COORDINATED

Meanwhile there has been legislation of perhaps more permanent value. It was found a waste of money to build wide, through highways avoiding built-up areas, because real-estate promoters promptly bought up the land on each side of the new roads and lined them with houses. Parliament has accordingly passed a law forbidding any building for a certain distance on each side of the through roads. Parliament has also given attention to other municipal problems. It has unified the city's transportation system by establishing the London Passenger Transport Board, with control over all bus, subway, and tramway systems in the city. Among other beneficial results, the subway or "underground" has become one of the cleanest and most comfortable in the world. Furthermore, the Board is carrying on an energetic and ingenious campaign to popularize the use of the subway for excursions into the surrounding countryside. As a result Piccadilly station, in the heart of the show district, is filled with boys and girls in hiking clothes every Sunday morning. Each year, old stations

© *London Passenger Transport Board*

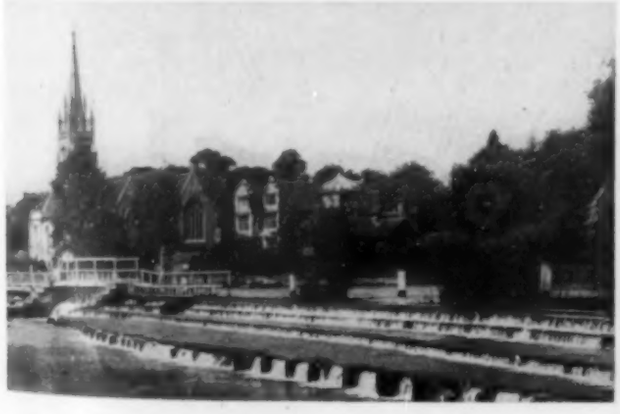
LONDON IS TAKING MEASURES TO IMPROVE TRAFFIC CONDITIONS
Traffic Circle at Southgate Station on the Piccadilly Line of the Underground

are either renovated or combined with others, and new ones are being built along modern lines in the outer ring of the subway.

There is a determined effort on foot to regulate the growth of London so as to preserve sufficient breathing space. The London County Council is buying land surrounding the city to maintain what it calls a "green belt." A great deal of attention is being given to the development of satellite towns, where people may live and work in the same place. This is a natural outgrowth of the "garden cities" movement, which has long been strong in England.

Naturally, peace and harmony are not entirely universal. Some disadvantages of London's twofold system of government have appeared in the treatment of the questions raised by the obsolescence of Waterloo Bridge. The national government is frankly a government of the county squires and the "best families"; the London County Council is as frankly a Labor Party machine. The Waterloo Bridge matter was tossed like a football between these two. Each tried for years to get as much credit for itself as possible, while in the meantime action on the question was delayed. The proposed bridge at Charing Cross, which many engineers claimed was the true solution, was lost in the shuffle.

But it is folly to expend vast sums of money on the improvement of a city if it is so open to aerial attack that it can be blown off the map in a single bombing raid. A large part of Britain's diplomatic activity is directed to the defense of its most vulnerable center, London. The activities of the army engineers have included the development of swift-climbing fighting planes, the careful and large-scale survey of the area about London, and the location of flying fields at strategic points. That all these efforts are acknowledged by the government to be inadequate is revealed by one little sentence tucked away in the proposal for the vast new program of aircraft construction: "The present proportion of bombers to fighting planes is three to one, and it is hoped to increase this ratio." From this, and from the plans being made to move the arsenals to Bristol, in the west of England, it seems evident that means for retaliation rather than for defense from aerial attack are being contemplated.



SCENE ON THE THAMES AT GREAT MARLOW
Watershed Under Authority of the Thames Conservancy

© The British Broadcasting Corporation

BROADCASTING HOUSE, PORTLAND PLACE, LONDON
The British Government Acquired Control of Radio Broadcasting in 1926

COMMUNICATION SYSTEMS AND POWER SUPPLY UNDER GOVERNMENT CONTROL

When London shall have ceased growing, the ultimate problem of social planning will still remain. However, England has peculiar advantages for a thoroughgoing planned development of its social and physical resources. The country is so small and compact that it is relatively easy to treat in a regional manner. It possesses a strongly centralized government having very wide latitude in the exercise of its powers. Through a period of many years and by virtue of stiff entrance examinations, it has developed an extremely competent civil service. A strong tradition of voluntary public service exists; the officials of local government receive in the main no salaries but are rewarded by the recognition of their fellow citizens. Finally, many functions—telephone and telegraph systems, for instance—which we in America are accustomed to consider the responsibilities of private corporations, have long been in the hands of the government.

The first important step towards unification was taken after the World War. At the outbreak of hostilities the government had taken over the 120 railroads then existing in Great Britain. In 1921, before handing them back to private owners, it consolidated them into four great systems. Much gain resulted, from the point of view of operating efficiency. It must be admitted, however, that when one tries to get from a town on one system to a town on another, he is apt to wish that the consolidation had gone a step further.

In 1921, radio broadcasting and receiving enjoyed its first great wave of popularity in America. The British Government perceived the meaning of this popularity before it reached England and was determined to be forehanded. There was no need for added authority; the Post Office Department already possessed absolute power over all communications. Negotiations were opened with the broadcasting groups of the time, and in

1922 the British Broadcasting Company was organized as a private corporation. This company was granted the monopoly of radio broadcasting in England, under government control and with profits limited. The income came from licenses for receiving sets, and advertising was forbidden. In 1926, when the shares of the company were bought at par by the government, the name was changed slightly to "British Broadcasting Corporation." The object was to make it a system "of national scale, for national service, and under national authority." The International Congress allotted England a total of eight medium wave lengths and one long wave length. An effort was made to space the eight medium-wave stations in such a way as best to serve the centers of population, and a very powerful long-wave station was built at Daventry to reach all those who could not receive the ordinary stations. The programs are a combination of national broadcasts released simultaneously over all stations, and regional broadcasts, consisting of programs from each station suited to the interests of the region it serves.

ABINGDON BRIDGE OVER THE THAMES NEAR OXFORD
This Bridge Was Built in 1416. The Navigation Arch Was Rebuilt in 1925, Using the Original Stone as Facing

Still another step in social planning was made in 1931 by the creation of the British National Power Scheme. This was designed to coordinate the entire electrical supply system of Great Britain by means of an electric grid connecting all producing plants (a large part of which are steam plants) and all distributing systems. The completed scheme has over 3,000 miles of primary transmission lines at 132,000 v, costing over $135,000,000. Electricity is now available to all except about 2 per cent of the population, of which the greater part is in the barren reaches of northern Scotland. That there is still great room for expansion appears from the fact that at present only 14 per cent of British homes are wired for electricity.

NATION-WIDE HOUSING AND WATER SUPPLY PROPOSED

Housing is another field in which national treatment is desirable, and here constructive and progressive spirit has been rather less in evidence. The plan has been to leave the situation to private enterprise; and since private enterprise is little likely to erect houses for lower-class working people when other lines of endeavor are more profitable, the population of England, after years of agitation, is still badly housed.

In the last two or three years England has suffered from a drought so severe that in many localities water has had to be hauled for miles. The question of treating water supply on a national scale naturally arose, and representations were made to the government with that end in view. With characteristic British caution, the government decided against the plan, holding that the possibility of such an extraordinary shortage of rainfall was so small as not to justify the huge capital expenditure necessary.

A work in which the English engineer has more to do than the American is the preservation and restoration of ancient monuments. For this purpose there is in the usual fashion an unpaid Commission on Ancient Monuments. One of the greatest tasks of this body has been the strengthening and restoring of St. Paul's Cathedral. The millions of dollars necessary for this work were raised by popular subscription. In every part of the island the practicing engineer meets the problem of restoring, strengthening, or widening old bridges to meet the demands of modern traffic. Some of these bridges are of great architectural merit, and there has been some very successful work, as at Abingdon and Bideford, in repairing them without altering their original appearance.

Voices favoring a different policy have not been lacking—voices calling for the construction of public works to achieve other than their own economic ends. Mr. Lloyd George, for instance, proposed a British "new deal." He had great popular support, but the government skillfully delayed the project until public interest had waned, and then quietly shelved it. British engineering continues to be characterized by organization, planning, rebuilding, and a strict regard for the principles of engineering economics in the formulation of projects. These are, in essence, the program and the work of a nation which has attained its maturity.

PART OF THE GREAT PORT OF LONDON
View from Shipboard Approaching King George V Dock

NEW SYRACUSE PASSENGER STATION AS IT WILL APPEAR WHEN COMPLETED

Elimination of Grade Crossings in Syracuse

Comprehensive Program Also Includes a New Passenger Station and Improved Shipping Facilities

By N. F. PITTS

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, SYRACUSE GRADE CROSSING COMMISSION, SYRACUSE, N.Y.

SYRACUSE, a city of 210,000 people, will lose the doubtful honor of having railroads operate through its streets late this fall, when the work of reconstructing the present two-track grade line of the West Shore Railroad as a three-track elevated structure is completed and the existing two-track New York Central surface line is abandoned. This $17,000,000 grade-crossing elimination project is being financed initially by state funds, but the cost will ultimately be distributed as follows: New York Central Railroad Company, 50 per cent; State of New York, 49 per cent; Onondaga County, 1 per cent. A new million-dollar passenger station forms a part of the project. The use of cellular-type bridge abutments in a number of locations and the ornamental treatment of plate girder spans constitute novel features of the work, which is being done by the railroad company under the general supervision of the Syracuse Grade Crossing Commission.

GRADE-crossing elimination work now under way in the city of Syracuse is the largest project of its kind in the state, outside of New York City. Referring to the map, Fig. 1, the extensive railroad facilities involved include the following: The two-track passenger main line of the New York Central proper; the two-track line of the West Shore Railroad, leased by the New York Central; the Syracuse Junction Branch; the Watertown Branch; the Chenango Branch; the Auburn Branch; two short industrial branches; and several yards, sidings, and team tracks. At the present time the New York Central main line passes through the city from east to west, occupying East Washington Street for a distance of approximately 1.4 miles. In this distance the tracks cross at grade 20 north and south streets, of which many are important thoroughfares in the business section of the city. Approximately 100 trains pass over the New York Central tracks daily.

The West Shore line runs on its own right of way nearly parallel to the New York Central and about four blocks to the north. This road crosses 23 streets at grade within a distance of about $2^1/_2$ miles. Many of these crossings also are in the business section of the city. The Watertown Branch enters the city from the northwest, and passes lengthwise through about a mile of streets, crossing a number of streets at grade. The Auburn Branch enters the city from the west, joining the New York Central main line at Syracuse Junction.

The Chenango Branch enters the city from the east, passing westerly through Canal Street for about a mile just south of the West Shore main line. This line in Canal Street handles only local freight, the passenger traffic being routed through the city over the main line of the New York Central. The Syracuse Joint Branch by-passes New York Central through freight around the north end of the city, a distance of about eight miles.

The project embraces reconstruction of the present two-track grade line of the West Shore Railroad as a three-track elevated structure to carry the traffic of the present New York Central passenger main line in addition to its own. This is to be followed by abandonment of the latter right of way. The three-track line will be elevated for a distance of approximately 5 miles through the city from Midler Avenue on the east to Syracuse Junction on the west.

Many changes are involved in carrying out this major improvement. Chief among these are the elimination of all New York Central main line, West Shore, and Watertown Branch crossings at grade; the removal of all main tracks from city streets, only those tracks being permitted to remain which are used for local freight service and industrial switching; elimination of the present Chenango Branch by the construction of a new connection with the main line east of the city limits; construction of new yards in the east end of the city, to be known as the Peat Street yards; construction of new perishable-freight yards; construction of a new passenger station, a mail and service building, and an express building; and installation of automatic train stops and electrically operated switches and signals.

WORK BEGUN IN EAST END OF CITY

The first construction work to be undertaken was the elimination

THE ELEVATED STRUCTURE CROSSES NORTH SALINA STREET ON A 109-FT PLATE-GIRDER SPAN

of crossings on Thompson Road and on Midler Avenue, at the east end of the city (Fig. 1). These intersections are isolated from the main project. Construction work on the Thompson Road elevated structure began in June 1930 and was completed the same year. This steel viaduct is 1,660 ft long and 50 ft high. It passes over two railroads, the New York Central and the West Shore, the latter overcrossing the former directly under the viaduct. In connection with this work, the Chenango Branch track was removed and a crossover was made to the West Shore Railroad east of Thompson Road. Upon completion of the entire project, Chenango Branch traffic will enter the city over the elevated West Shore line.

The Midler Avenue viaducts, spanning the West Shore and New York Central lines, are to be completed this year. They will provide a new crosstown thoroughfare unobstructed by railroad crossings at grade. During 1932 and 1933 the Peat Street yards and the perishable freight yard were constructed, and the First Ward Branch freight connection was constructed to serve industries on the north side of the city.

The main contract for such work as grading, retaining walls, bridges, and culverts, was awarded in December of 1933, and actual construction work started early in the spring of 1934. This contract, which is substantially completed, involves 27 bridges, 2,000,000 cu yd of embankment, 12,000 tons of structural steel and 100,000 cu yd of concrete masonry.

The elimination project has necessitated the acquisition of over 300 parcels of real estate. Approximately 60 miles of single track in main line, sidings, and yards are involved. All track-work and signals are being installed by railroad forces. Twenty-seven streets and two streams have been bridged, four streets closed, and three new streets opened to traffic. Fifty-four dangerous crossings have been eliminated. Street grades have not been altered except in a few cases, where they have been improved. Instances of grade changes constituting improvements may be cited at three points in the most easterly section of the city. All existing important highways have been spanned by wide bridges. The clearance at all bridges has been maintained at a minimum height of 14 ft, with 15 ft or more in the center of the city, thus providing proper light and air in the underpasses. The elevated tracks are supported between streets on earth embankment with natural side slopes, except at certain points where the construction of concrete retaining walls has been made necessary owing to the limiting width of the right of way.

Of the 27 bridges mentioned, one is a vehicular overpass; eight are of the longitudinal I-beam type; 12 are of the deck plate-girder type; five are through plate-girder bridges; and one is a reinforced concrete double box culvert. Thirteen of the bridges are single span between abutments, and nine employ center columns. In one case only are curb columns used, and in another both curb and center columns are used. All bridges on the improvement will be painted with aluminum paint, which gives an attractive finish. The use of this paint is a departure from the customary treatment of bridges in this vicinity.

Mass-type concrete abutments have been used for all bridges supported on piles or hardpan, except in a few special cases. Soil conditions are extremely poor at

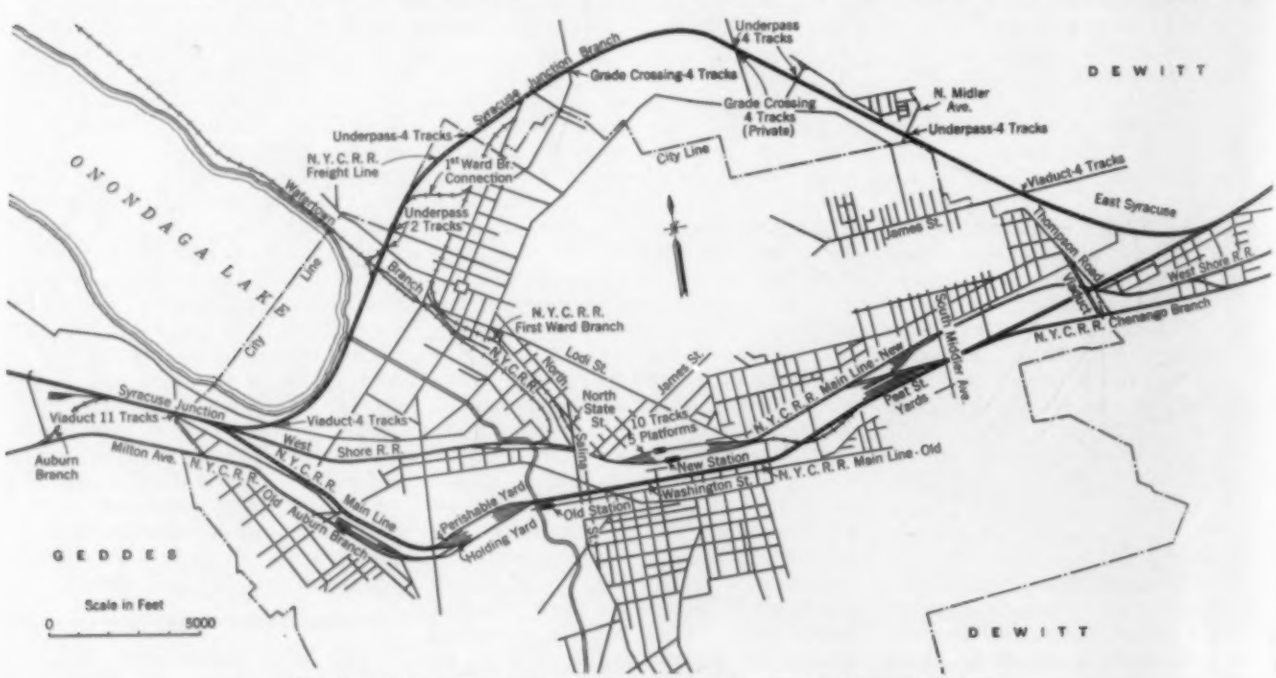


FIG. 1. PLAN OF SYRACUSE, N.Y., SHOWING NEW YORK CENTRAL TRACKS

the four westerly street crossings, where the tracks are about 40 ft above the street grade. Here the abutments for the bridges were built of cellular walls. The advantage of this type of construction is the elimination of practically all the horizontal thrust of the fill and the distribution of the vertical load over a large area directly under the tracks.

The cellular type of abutment, shown in Fig. 2, is built on a 4-ft, heavily reinforced concrete footing, 50 ft square, supported by concrete piles 40 ft in length. The bridge superstructure rests upon the front wall, which is about 6 ft in thickness. From this wall run four longitudinal walls 30 in. wide for the full depth and height of the abutment. These walls carry a deck slab with side parapet walls, forming a three-cell box with the rear end open. The interior is filled with gravel for the full height at the rear and forms a natural slope to the footing at the front. All walls and slabs are heavily reinforced and tied together.

One of the chief objections to the plan finally adopted was the possible creation of unsightly elevated structures, particularly at the intersection of State and James streets. State street carries the bulk of the north and south traffic through the city, and James Street leads to a beautiful and thickly populated residential district. The new elevated structure crosses diagonally immediately adjacent to this intersection on a 3-deg curve.

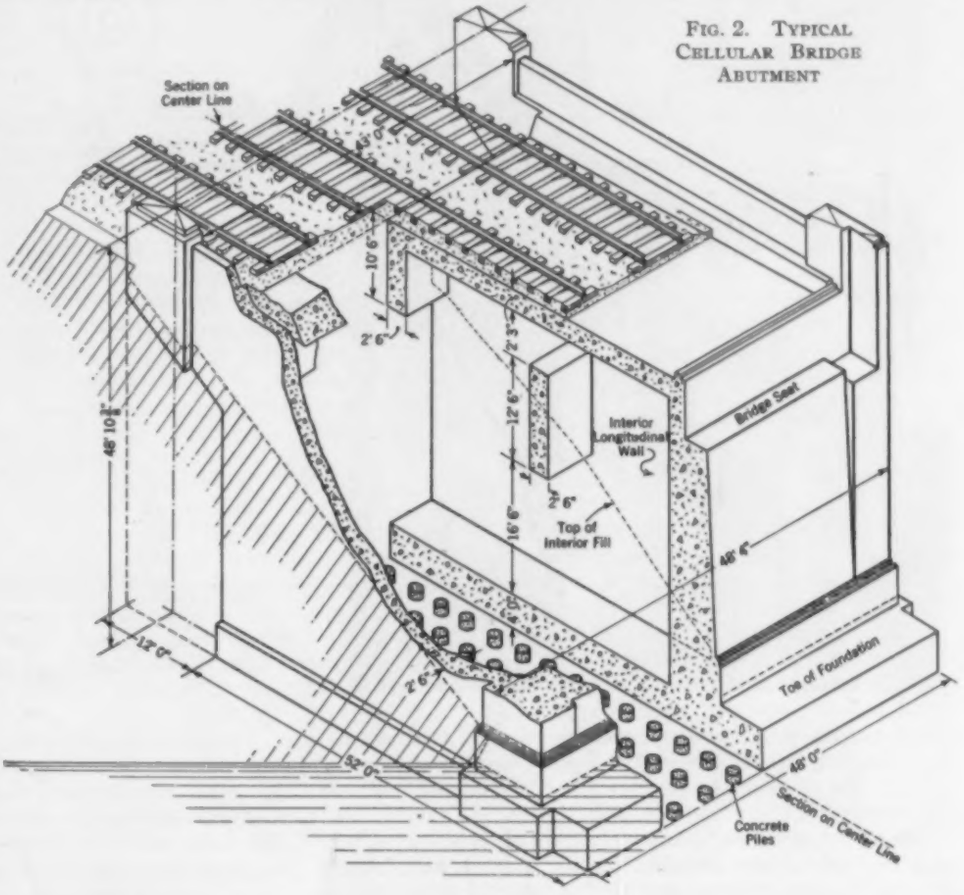


FIG. 2. TYPICAL CELLULAR BRIDGE ABUTMENT

CLOSE ATTENTION GIVEN TO APPEAR..NCE OF BRIDGES

A great many studies were made of types and treatment of bridge structures before a plan was presented by the Syracuse Grade Crossing Commission for a structure at this location. The plan called for two 76-ft spans on State Street and a single 107-ft span on James Street, with no changes in street grade. The bridge structures were to be of the plate-girder type. The steel girders were to be hidden by independent steel box plate girders, faced with stone, the soffit taking the form of an arch. The abutments and pylons were to be faced with stone. Because of the excessive cost of this treatment, the plan was rejected by the Public Service Commission. A plan submitted by the railroad company was later adopted. This kept approximately the same spans, the stone facing of the abutments, center columns, and pylons, but eliminated the stone facia girders and applied ornamental treatment to the exterior of the girders. The same treatment was applied to three adjacent structures, at Oswego Boulevard, Willow Street, and Salina Street, respectively.

The design of these five bridges is unusual. This is especially true of the structures at James Street (Fig. 3) and at Salina Street, which have spans of 107 ft and 109 ft, respectively. Because of the right of way, street headroom, and clear spans required, the structure was limited to two outside girders. These are 45 ft 1 in. apart, center to center, a width sufficient to provide space for three tracks. In the two longest spans, nickel steel was specified for the girders. The upper flange of the girder on Salina Street has a section modulus of 26,900 in., and the lower flange a section modulus of 22,100 in. For floor beams, 36-in. 300-lb rolled I-beams on 2-ft $2^1/_2$-in. centers, with a $^5/_8$-in. deck plate, were used.

The calculated end reaction of these girders, 988 tons, is carried through a steel column concreted in the abutment to the footing below street level, and thence through a concrete pier to bedrock at about 21 ft below the street grade. The footing of the abutment was carried to hardpan about 13 ft below the street level.

The exterior face of the girders is uniformly paneled. An ornamental steel plate, with medallions, is tapbolted to the web plate for the full depth between flange angles, shielding the numerous rivet heads of the floor beams and web splices. Both flanges are likewise masked. All joints are closely fitted, welded, and ground smooth. All exposed areas are given two coats of aluminum paint. Each of the Salina Street girders has an overall length of 112 ft 10 in. and weighs 149 tons. The James Street girders weigh 142 tons each.

In erecting the girders for these five bridges, a ramp was constructed from an adjacent team track up to the easterly abutment of State Street, and a temporary timber trestle was constructed across the street between the abutments. The girders were hauled up onto this

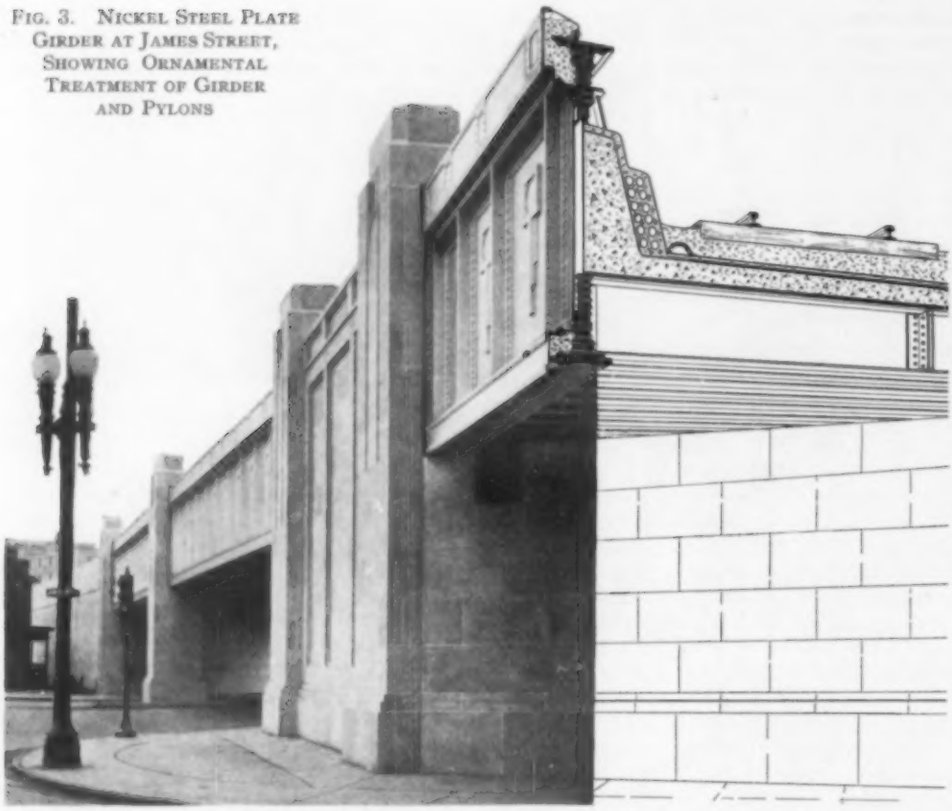


FIG. 3. NICKEL STEEL PLATE GIRDER AT JAMES STREET, SHOWING ORNAMENTAL TREATMENT OF GIRDER AND PYLONS

trestle and were lifted into place by two 150-ton railroad wrecking cranes. While the floor beams were being placed, the trestle was removed and placed on the next adjacent street.

These structures cannot be considered unsightly and certainly do not obstruct traffic. This is particularly true at James, Willow, and Salina streets, where single spans have been used.

NEW PASSENGER STATION IS UNDER WAY

The contract for the new passenger station was about 50 per cent complete on January 1, 1936. The building is 80 by 160 ft. Its central part is four stories in height, and the two wings are three stories each. The building has a structural steel frame with face brick, except in the center part, where limestone facing is used. Limestone is used for trim on the exterior walls. Granite is used in the building base course.

The foundations and structural steel frame for the mail and service building are in place. This two-story building is approximately 157 by 46 ft, of reinforced concrete with face-brick walls and limestone trim. It will be completed this summer. The rest of the buildings planned for the station area—an express building and a car facility plant—will be erected during the summer.

Briefly, the track layout for the passenger station will comprise 10 through station tracks, in pairs, with 5 platforms, in addition to 3 stub tracks and 2 sidings, all built on embankment. The passenger platforms are to be approximately 1,450 ft long, 22 ft wide, and will be provided with canopies. These tracks at the station site will be about 20 ft above the city streets at this location.

The source of the embankment material is about 12 miles east of the city, near the West Shore right of way. The material has been taken from level ground, excavations running to a depth of 30 ft. A sizable lake has been created because the elevation of ground water in that vicinity is about 10 ft below the existing ground surface. An exceptional quality of run-of-bank gravel has been obtained owing to the small percentage of clay. At the side of the borrow pit a large modern gravel-washing plant has been erected, which provides all the sand and gravel required on the elevation project.

The embankment material is transported to the city in dirt trains, each made up of approximately 50 cars. About 7 trains a day are operated from the borrow pit, each transporting from 7,000 to 8,000 cu yd of material. The material is dumped from the dirt trains operating on an adjacent construction track at grade. The embankment for one track is then built up to its full height by dragline. The remainder of the fill is side-dumped from a track on this high level.

The entire project is being financed in the first instance out of funds raised by the State of New York. In 1925 a state referendum authorized the expenditure of $300,000,000 for the elimination of grade crossings within the state, and $26,000,000 of this amount was allocated to Syracuse. At the completion of the work, the New York Central Railroad Company will be assessed 50 per cent and Onondaga County 1 per cent, to be repaid to the state in 50 equal annual installments. The state will defray the remainder of the cost.

The approximate total cost of the grade elimination work is made up as follows:

Land	$6,500,000
Main contract	4,500,000
Signals and track-work	3,500,000
Passenger station, mail and service building, and heating plant	1,000,000
Thompson Road Viaduct, Midler Avenue Viaduct, Peat Street yards, perishable-freight yards, and First Ward branch connection	1,000,000
Miscellaneous	500,000
Total	$17,000,000

It is now proposed to complete the elevated structure and put it into operation in the early fall of 1936. In the meantime all track-work and signals are to be installed and the station buildings completed.

The work is being prosecuted by the New York Central Railroad Company, under order of the Public Service Commission of the State of New York and under the general supervision of the Syracuse Grade Crossing Commission. Plans were prepared by the railroad company, J. W. Pfau, chief engineer. The work of the main contract, including grading and constructing retaining walls and bridges, was done by the Walsh Construction Company. The station buildings are being erected by William M. Ballard, Inc.

Discharge Characteristics of the Free Overfall

Use of Crest Section as a Control Provides Easy Means of Measuring Discharge

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REFINEMENTS are constantly being introduced in the methods of measuring flowing water. In recent years, many attempts have been made to avoid the necessity of calibrating each individual measuring device, by utilizing the principle of critical depth for parallel flow. Unfortunately, in the critical-depth meters thus far devised, it has been impossible to prevent the apparent control section from shifting indeterminately upstream or downstream as the discharge varies, and so the need for experimentally determined coefficients has not yet been eliminated. In the present article Dr. Rouse points out the possibility of using the free overfall as a flow meter which needs no calibration. Although the flow at the overfall is not parallel, the crest section is that of true minimum energy and hence is the actual control section. Furthermore, the crest depth is a constant percentage of the computed critical depth for parallel flow. Dr. Rouse's analysis has been verified by experiment, and should provide a dependable and simple means of determining discharge at points of overfall.

CONSIDERABLE attention has been given in engineering literature to the measurement of flowing water by means of critical-depth meters of one form and another. In this category fall such hydraulic devices as the broad-crested weir, the venturi flume, and similar contractions of the flow section, which presumably cause the critical depth to occur at some point along the flow profile. Numerous publications have cited efforts to control the longitudinal position of this critical point, in order that a single measurement of depth at one established section might permit a direct computation of the discharge.

As yet no satisfactory degree of success has been attained in these efforts. All measuring devices of this type require careful rating before accurate results may be expected, because a variable coefficient must be applied to the expression for critical flow; this is largely to compensate for the fact that the apparent critical section wanders upstream or down with changing discharge, so that the depth at the established point of measurement is seldom equal to the critical.

Three fallacies in reasoning lie at the root of the poor success of these investigations:

1. The shape of the flow profile is directly dependent upon the relation between a variable discharge and a constant geometrical form of the hydraulic device. Since the surface profile must then vary in shape as the discharge changes, geometrical similarity between any two discharges is impossible, and hence complete dynamic similarity is quite out of the question. Obviously no single section can be chosen at which the computed critical depth may be expected to occur for two different rates of flow, for no two flow profiles are either geometrically or dynamically similar. It is evident that the only type of meter which might have a constant discharge coefficient—that is, the only universal critical depth meter—must be of such form that the flow profile will always bear the same geometrical relationship to the flow boundaries, regardless of change in head. This condition is possible, for instance, in the case of a ventilated, sharp-crested, suppressed weir of infinite (that is, extremely great) height, sloping at any desired angle within reasonable limits; the free overfall at the end of a long channel is one specific case of such a weir, the weir face then being approximately horizontal.

2. The familiar expressions for critical velocity, depth, and discharge are based upon conditions of linear motion with static pressure distribution; once curvilinear flow occurs, these expressions cannot be expected to apply, for the sum of pressure head and elevation is no longer equal to the depth. Obviously, any abrupt change of section—the very basis of weirs and venturi flumes—is accompanied by appreciable curvature of the flow profile, so that a depth equal to the computed critical depth is seldom found at a point of parallel flow.

3. The true section of minimum energy is that at which the sloping energy line reaches its minimum elevation above the lower boundary of flow, regardless of the degree of curvature of the flow in this region. In the case of an overfall at the end of a mild slope, the true critical section is located at the overfall crest; in the case of a sharp-crested weir, on the other hand, it lies at that point of the free nappe at which the lower surface has attained its maximum elevation. Unfortunately, however, neither is the discharge always a constant function of this true critical depth, since it may vary with change in the boundary conditions, nor is it as yet possible to determine analytically the form of this function for any given case of curvilinear flow.

Restricting this discussion to the problem of two-dimensional flow (the side walls of the channel remaining parallel throughout), the phenomenon of the free overfall may be used to illustrate the three principles in question. The overfall is of distinct importance in hydraulic engineering, aside from its close relation to the broad-crested weir, for it forms the starting point in computations of the surface curve in non-uniform channel flow in which the discharge spills into an open reservoir at the downstream end.

According to the principle of minimum energy in parallel flow, a given rate of discharge carried by a long canal of mild slope ending in an abrupt fall will flow under conditions of minimum specific energy or total head—

SYMBOLS USED IN THIS ARTICLE

Q	= rate of discharge	g	= gravitational acceleration
S	= channel slope	b	= channel width
A	= cross-sectional area of flow	d	= depth of flow at any section
C	= Chezy coefficient	d_c	= critical depth for parallel flow (hydrostatic critical depth) $= \sqrt[3]{\frac{Q^2}{b^2 g}}$
c_q	= discharge coefficient		
c_c	= contraction coefficient		
c_v	= velocity coefficient		
H	= specific energy of flow or total head above channel floor	d_0	= depth at overfall crest (true critical section)
V	= average velocity over a vertical section	h	= head on weir
V_a	= average velocity of approach	p	= pressure intensity
		γ	= specific weight of fluid

that is, at the critical depth for parallel flow—at some section a short distance upstream from the fall. This critical depth is given by the following relationships (Fig. 1):

$$d_c = \frac{2}{3} H_e = 2\frac{V^2}{2g} = \sqrt[3]{\frac{Q^2}{b^2 g}}$$

If the slope of the channel is such that the normal depth for uniform flow is exactly equal to the critical depth, that is, if

$$S = \frac{Q^2}{A^2 C^2 R} = \frac{V_c^2 (b + 2d_c)}{C^2 b d_c},$$

then at no point upstream from the crest will the depth be greater than d_c. Since the critical slope decreases with decreasing rate of energy loss—that is, with increasing values of C—a minimum slope of zero would represent a state of flow without any loss whatever, and the energy line would then be horizontal. Under these limiting conditions the flow would remain at the critical depth—that is, the surface would be horizontal—so long as the conditions of hydrostatic pressure distribution were fulfilled.

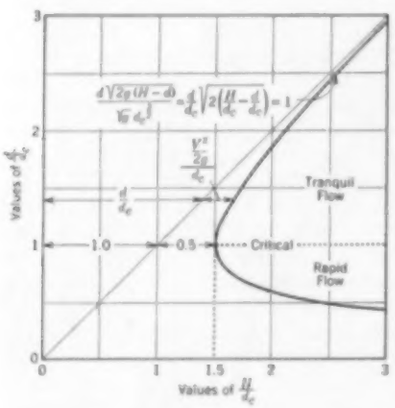


FIG. 1. DIMENSIONLESS SPECIFIC ENERGY DIAGRAM

PRESSURE DISTRIBUTION IN THE REGION OF THE CREST

At the lower end of the channel, however, the downward curvature of the discharging nappe of water produces a non-static distribution of pressure, as shown in Fig. 2(*a*) (drawn schematically after measurements by the author; see *Die Verteilung der hydraulischen Energie bei einem lotrechten Absturz*, H. Rouse, Oldenbourg, Munich, 1933). In the case of complete aeration, the pressure below as well as above the nappe must be atmospheric. Contrary to prevalent assumptions, however, it does not follow that the pressure within the nappe at the crest is also zero—in fact, there still exists considerable internal pressure in this region, caused by the convergence of the stream filaments between the upper and lower surfaces of the flow. As the filaments become more nearly parallel lower in the fall, this internal pressure gradually approaches zero as shown. Upstream from the crest there must be a gradual downward curve of the surface, since, in accordance with the energy principle, the decrease in pressure as the crest is approached signifies an increase in velocity, and the continuity principle in turn requires an accompanying decrease in depth. Mathematically speaking, this downward curve begins an infinite distance upstream from the crest. For all practical purposes, nevertheless, it may be assumed that the depth is equal to the hydrostatic critical over the entire length of the channel, with the exception of a relatively short region near the crest.

Once resistance losses become appreciable, this basic picture of critical flow in a horizontal channel must be modified. As seen from the dimensionless energy diagram of Fig. 1, the critical depth for any given discharge under static pressure conditions occurs at the point of minimum specific energy or total head. As the channel remains horizontal, loss of energy causes the total head to decrease in the direction of flow, approaching this minimum value in the neighborhood of the crest. That is, the depth will increase in the upstream direction as shown by the upper part of the energy diagram. The maximum depth far upstream is limited only by the length of the channel and the rate of energy loss.

Since the surface curve is no longer horizontal, it is illogical to presume that the hydrostatic critical depth now occurs over even a small part of the channel length. Actually there is but one vertical section at which the computed critical depth may be found. At that section the surface slope resulting from wall and floor resistance joins the curve of transition to the fully ventilated nappe. Since for the case of negligible resistance the critical depth was an extremely great distance upstream, it might be reasoned that increasing resistance (hence increasing slope of the surface) would cause the computed critical section to move nearer and nearer to the crest; experimental evidence justifies this reasoning, although it is still impossible to predict the location with any accuracy. For relatively smooth channels it is a distance equal to approximately four times the critical depth upstream from the crest.

All curves of pressure distribution within the nappe in Fig. 2(*a*) apply with negligible change to the actual case of Fig. 2(*b*). As is shown by the curve of measured floor pressures, at the computed critical section the pressure is still statically distributed, so that the critical relationships already cited are still applicable. Using this section as the upper limit, it is possible through use of the momentum principle to determine the vertical dimension of the nappe at point 1, where internal pressure no longer exists. Neglecting the small boundary resistance over this short channel length, the only

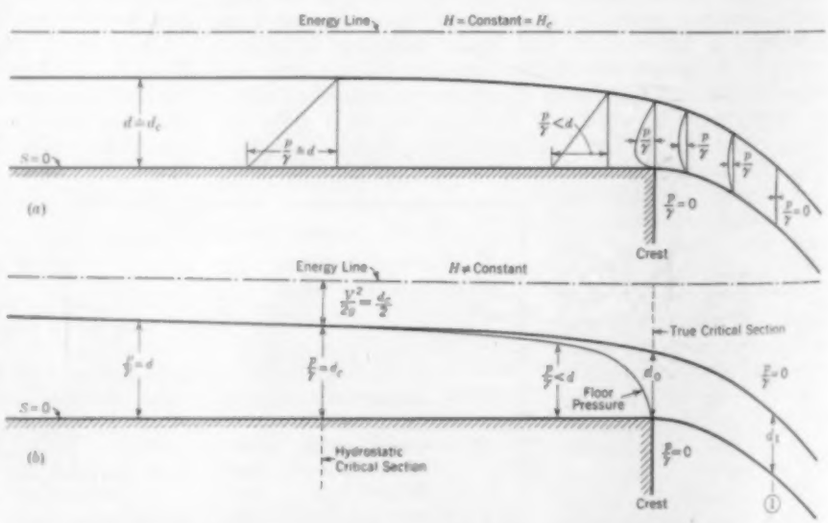


FIG. 2. SURFACE PROFILES AND PRESSURE DISTRIBUTION AT A FREE OVERFALL
(*a*) Assumed Case of Constant Specific Energy. (*b*) An Actual Profile; Pressure Distribution in the Nappe Is Similar to That in (*a*)

force causing the rate of change of momentum in the horizontal direction is the static pressure over the critical section. For all practical purposes this is equal to the mass discharge past either section multiplied by the change in the average horizontal component of velocity:

$$\frac{\gamma d_c^3 b}{2} = \frac{Q\gamma}{g}\Delta V = \frac{Q^2\gamma}{gbd_1} - \frac{Q^2\gamma}{gbd_c}$$

Now since $d_c^3 = \frac{Q^2}{gb^2}$, we can write this equation as $\frac{d_c^2}{2} = \frac{d_c^3}{d_1} - \frac{d_c^3}{d_c}$, and, solving, $d_1 = \frac{2}{3}d_c$.

Experiments have shown that below the level of the crest, where the pressure within the nappe has become practically atmospheric, the vertical dimension of the sheet is only very slightly greater than two-thirds the critical depth (because of the neglected frictional loss), remaining practically constant through the downward course of the sheet.

DEPTH OF FLOW AT THE CREST

Since the pressure distribution at the crest section as shown in Fig. 2(*a*) cannot be found without rather laborious hydromechanical methods, the principle of momentum is not sufficient to determine the depth of the flow at this point. (The hydromechanical methods are described in the thesis already referred to.) Recourse may be had, nevertheless, to a method which has a certain schematic significance—although it is still without concrete physical justification. The basic weir formula,

$$Q = c_c \frac{2}{3}\sqrt{2g}\, b\left[\left(h + \frac{V_a^2}{2g}\right)^{3/2} - \left(\frac{V_a^2}{2g}\right)^{3/2}\right]$$

in which c_c represents the so-called coefficient of contraction, assumes horizontal, parallel flow at zero pressure at a section similar to the vena contracta of an orifice under very high head; obviously, neither is the nappe of a weir a case of either horizontal or parallel flow, nor is the internal pressure atmospheric. Be that as it may, the above equation may be rewritten in terms of a general discharge coefficient, c_q, so that

$$Q = c_q \frac{2}{3}\sqrt{2g}\, bh^{3/2}$$

The coefficient c_q is then the product of c_c and another coefficient, c_v, which includes in dimensionless terms the velocity of approach:

$$c_v = \left(\frac{h + \frac{V_a^2}{2g}}{h}\right)^{3/2} - \left(\frac{\frac{V_a^2}{2g}}{h}\right)^{3/2}$$

Assuming now that the free overfall is a sharp-crested weir of zero height, and that the discharge head is the critical depth ($h = d_c$), the discharge coefficient c_q may be computed from the critical discharge relationship:

$$Q = \sqrt{g}\, bd_c^{3/2} = c_q \frac{2}{3}\sqrt{2g}\, bd_c^{3/2}$$

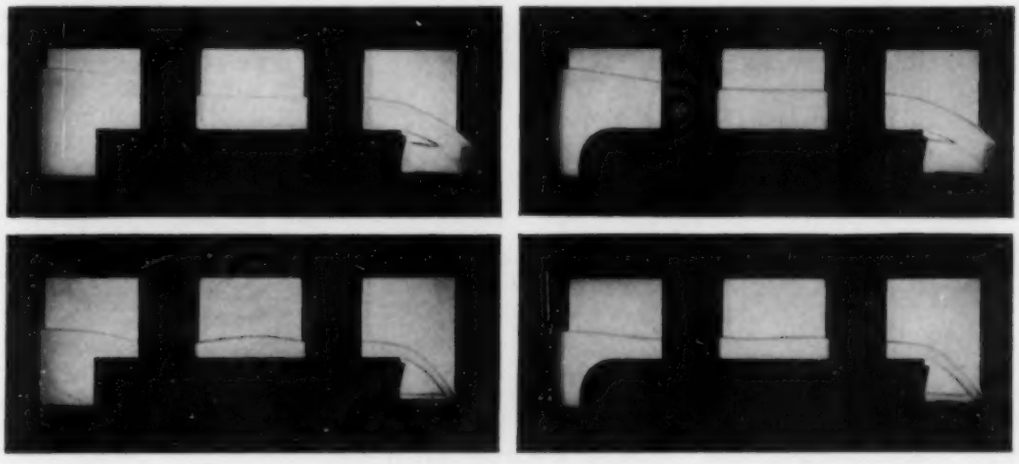
$$c_q = \frac{3}{2\sqrt{2}} = 1.061$$

c_v may also be computed from the relationship between hydrostatic critical depth and velocity head:

$$c_v = \left(\frac{1 + \frac{1}{2}}{1}\right)^{3/2} - \left(\frac{\frac{1}{2}}{1}\right)^{3/2} = 1.485$$

From these two values, there results for the coefficient of contraction c_c:

$$c_c = \frac{c_q}{c_v} = \frac{1.061}{1.485} = 0.715$$



EFFECT ON SURFACE CURVE PRODUCED BY CHANGING THE PROFILE OF A BROAD-CRESTED WEIR
The Measured Heads in Views on Right Are the Same as Those in Corresponding Views on Left

Numerous measurements by the author have shown that this contraction coefficient is equal to the ratio between crest depth and computed critical depth, regardless of rate of discharge or channel width. (For first mention of this fact see "The Distribution of Hydraulic Energy in Weir Flow with Relation to Spillway Design," by H. Rouse, submitted in partial fulfillment of the requirements for the degree of master of science in civil engineering, Massachusetts Institute of Technology, 1932.)

Thus, despite the fact that the hydrostatic critical section for parallel flow has no definite location, but changes position with rate of discharge and channel slope and roughness, it is evident that the crest section itself, in a free overfall, is the true section of minimum energy, and as such is a suitable control point at which a single measurement of depth should permit a simple and direct determination of the rate of discharge:

$$Q = \sqrt{g}\, bd_c^{3/2} = 1.654\sqrt{g}\, bd_0^{3/2} = 9.4\, bd_0^{3/2}$$

The success of this determination, of course, would depend upon complete aeration of the nappe and a continuation of the channel sides a short distance beyond the crest. Needless to say, such depth measurements cannot be made by floor or wall piezometers, for decidedly non-static pressure conditions prevail in this region.

At this point reference must be made to a paper by P. Böss, which has been translated in this country

and is often quoted in engineering literature ("Berechnung der Abflussmengen und der Wasserspiegellage bei Absturzen und Schwellen . . .," *Wasserkraft und Wasserwirtschaft*, Heft 2–3, 1929). In this article the discharge is computed on the assumption of linear pressure distribution at a vertical section of curvilinear flow; as this signifies zero pressure over the entire crest section of a ventilated overfall, the equation yields a value of

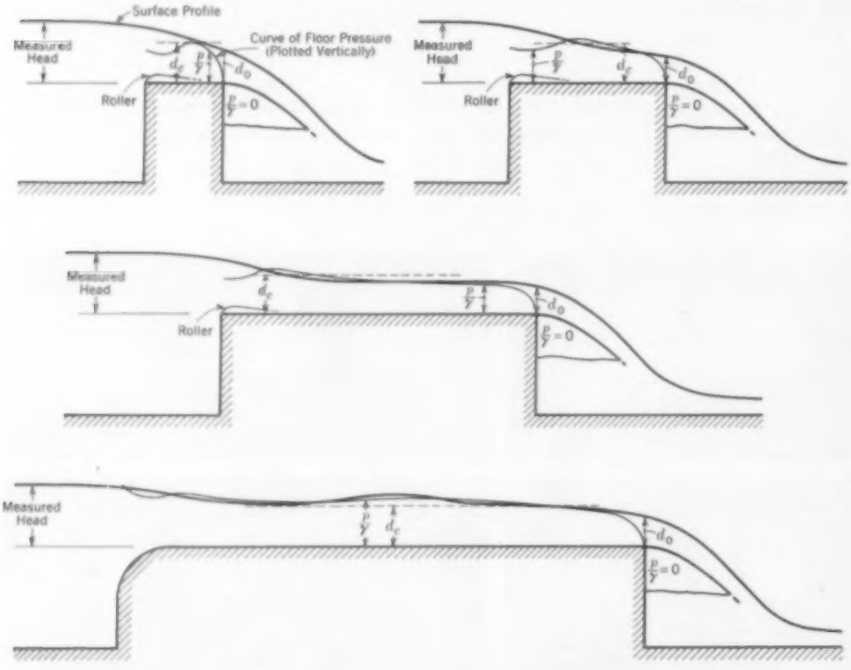


FIG. 3. TYPICAL SURFACE PROFILES AND PRESSURE DISTRIBUTIONS FOR BROAD-CRESTED WEIRS OF VARIOUS PROPORTIONS

$\frac{d_0}{d_c} = 0.656$, which differs by more than 8 per cent from the value of 0.715 derived herein and substantiated experimentally.

EFFECTS OF THE BREADTH OF THE WEIR

Considering now the broad-crested weir, it is evident that the surface curve of the free overfall will be transformed by another local transition curve a relatively short distance upstream from the crest. That is, a short distance upstream from the weir the water will flow at great depth and low velocity, and at the upper end of the weir there will be a surface drop and an abrupt acceleration. If the weir is very broad, it is reasonable to expect the first transition curve to end some distance upstream from the transition of the crest region. A narrow weir, however, may result in a mutual interference of the two transition curves, in which case neither attains its full independent form. See Fig. 3 for typical profiles. The sharp-crested weir is the limiting case of such interference, the two curves here being blended into a single smooth profile.

If the upstream end of the weir is a sharp corner—the intersection of the vertical face with the floor—a region of discontinuity forms between the flow and the floor of the weir, this region being filled with a roller of water as shown in Fig. 3. Since the roller is not a part of the live flow, the discharge passes over it as though the roller were a small spillway built upon the weir. Because of the effective height of this roller above the weir floor, the flow reaches its toe at a velocity somewhat above the critical, and the surface thereafter is either highly undular (for very broad weirs) or of the general rising profile typical of such rapid motion, depending upon the ratio between the head, h, and the weir breadth. If the upstream end of the weir is rounded sufficiently, this roller and the accompanying rapid flow will no longer exist. The surface will remain undular, however, unless the rounding be exceedingly gradual, but the critical depth will not occur until the transition region of the crest is reached.

It must be noted that the position and number of the surface undulations depend entirely upon the geometrical relation between the head on the weir and the weir dimensions. Any undulation for a given weir profile will move downstream with increasing discharge, until it becomes absorbed in the lower transition curve. At the same time it is apparent that the position of these reaction waves, as determined by the magnitude of the head and the form and length of the weir, will influence the lower transition curve to such an extent that the hydrostatic critical section will be moved upstream or downstream from its corresponding position for the free overfall. A narrow weir, moreover, will have no section at which the critical depth for parallel flow may properly be located, because of curvature of the filaments over the entire profile.

Whether the crest depth itself remains unchanged in its relation to the computed critical depth, as the breadth of the weir varies, may be determined by experiment alone. Obviously a very narrow weir must at once be eliminated from this consideration, for the sharp-crested weir as a limiting case surely does not display this constant relationship. It remained for a recent investigation of the broad-crested weir, conducted in the Fluid Mechanics Laboratory at Columbia University, to supply the necessary experimental test of this point ("The Hydraulics of the Broad-Crested Weir," by T. H. Prentice, a thesis submitted in partial fulfillment of the requirements for the degree of master of science, Department of Civil Engineering, Columbia University). The experiments were conducted on a series of weirs 1, 2, and 3 ft in breadth, with both square and rounded upstream ends, under heads varying from 0.2 to 0.6 ft. While the progression of undulations resulted in an average deviation from the mean of $\pm 1\frac{1}{2}$ per cent, the general average value of $\frac{d_0}{d_c} = 0.712$ for all weirs except the shortest (25 different profiles) is strikingly close to the value of 0.715 derived from the weir equation. On eight different heads for the free overfall, the author had previously found a mean value of 0.716, with an average arithmetical departure from 0.715 of 0.5 per cent.

While further large-scale experiments are now in order, including channels with mild slopes and various values of the roughness coefficient, the author believes that the use of the crest section as the control point for measurement of discharge will not only further the laboratory search for a satisfactory critical depth meter, but will provide a simple and dependable method of determining discharge in rectangular channels that end in a free overfall.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Determining the Economical Size of a Power Plant

By JOSEPH D. LEWIN, JUN. AM. SOC. C.E.

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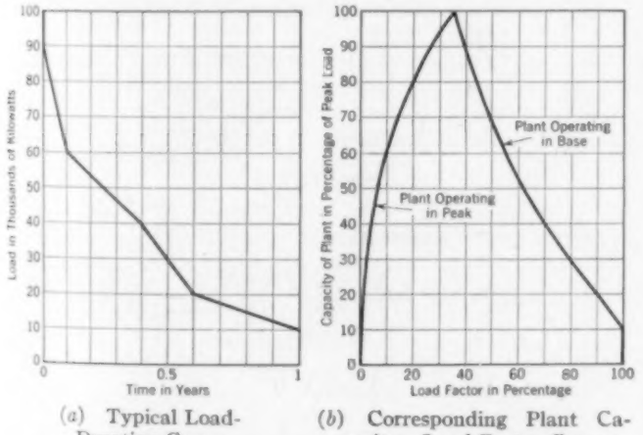
WITH the many possibilities for interconnection of power stations that exist today, it is seldom economical to design a new plant to take all of an existing or assumed load. The station capacity is more often set at or near the point at which the estimated cost of power per kilowatt-hour, based on the assumed load curve, is a minimum; the remainder of the load may then be supplied from some other source.

Until a few years ago the load curve, with its daily and annual periodic variations—in brief, the actual condition of load on the plant—was hardly taken into consideration in selecting plant capacity; rather, average figures of 3,000 to 5,000 kw-hr per year per kilowatt of installation were accepted. In other words, a fixed load factor was usually assumed. But this cancels the entire influence of the load factor and produces a result that does not necessarily correspond to conditions. An accurate determination of the economic size requires a careful economic analysis that takes all factors fully into consideration. The method described here meets that requirement and is both accurate and rapid.

Let us assume that the load-duration curve, Fig. 1(*a*), has been constructed from the load curve in the usual manner. Now for any size, N_1, of power plant, there is a definite number of kilowatt-hours, A_1 (the area under the duration curve up to N_1), that will be supplied by the plant. The corresponding load factor is $\frac{A_1}{8{,}760\ N_1}$. By computing thus the load factors for various values of N, the right-hand part of the curve of Fig. 1(*b*) can be constructed.

The ordinates of this curve have been plotted as percentages of the peak load. It is read as follows: A plant with a capacity of 40 per cent of the assumed peak load would operate at a load factor of 70 per cent.

The left-hand part of the curve is constructed in the same manner, but working downward from the top of Fig. 1(*a*). That is, this part of the curve represents the conditions when the hypothetical plant is operating in the peak instead of in the base. We read, for example, that a plant with a capacity of 60 per cent of the assumed maximum load, if operated to supply peak loads, would operate at a load factor of 10 per cent.


Load in Thousands of Kilowatts
Time in Years
Capacity of Plant in Percentage of Peak Load
Load Factor in Percentage
Plant Operating in Base
Plant Operating in Peak

(*a*) Typical Load-Duration Curve

(*b*) Corresponding Plant Capacity – Load Factor Curve

FIG. 1. BASIC CURVES FOR DETERMINING ECONOMIC SIZE OF POWER PLANT

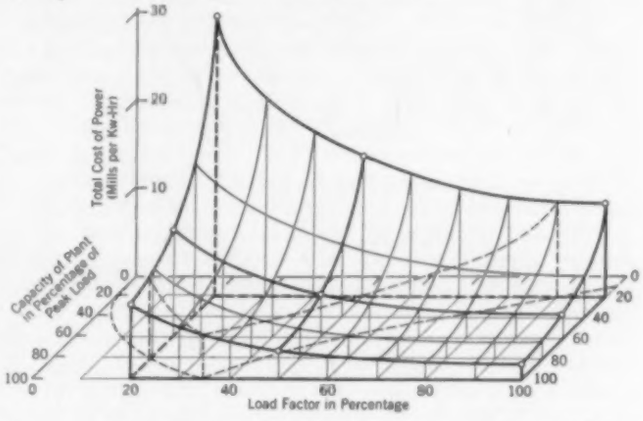


FIG. 2. THREE-DIMENSIONAL REPRESENTATION OF THE RELATIONSHIP BETWEEN PLANT SIZE, LOAD FACTOR, AND COST OF POWER

The Entire Cost Surface Was Determined with Sufficient Accuracy by Computing the 9 Points Marked with Circles

Let us now consider costs of production. These may be considered as made up of two parts—one, fixed charges and such operating costs as depend mainly on the size of the plant and are not appreciably dependent upon the amount of power produced; the other, operating charges such as fuel, personnel, and repairs, which depend mainly upon the amount of power produced, and to only a minor degree upon the size of the plant. Reducing these to costs per kilowatt-hour, the first part varies inversely with the number of kilowatt-hours produced, for a plant of any given size, while the second is practically constant. The cost–load factor curve for any plant is therefore roughly parabolic. Now if we consider several plants of various sizes operating at the same load factor, it is obvious that the second part of the cost of production will be just about the same for all the plants, while the first part of that cost will vary inversely (approximately) with the size of the plant. The cost–plant size curve for any given load factor is therefore also parabolic.

A series of cost computations for plants of various sizes will permit us to construct both the cost–load factor curves and the cost–plant size curves. In general, because of their parabolic form, we need to compute only 9 points to determine the entire field. If the plotting is done on a space coordinate system like that of Fig. 2, the picture is much clearer, and moreover we can now

determine immediately the size of installation which, for the assumed load curve, will produce power at the least cost per kilowatt-hour. For the horizontal plane has as coordinates plant size and load factor, and the curve of Fig. 1(*b*) can easily be reproduced upon it. It is then a simple matter to project this curve upward onto the cost surface, and to locate the lowest point of this line of intersection. In the example given, Fig. 2 indicates that a plant with a capacity of about 75 per cent of the maximum load, operating in the base, would supply power at the lowest cost per kilowatt-hour. The corresponding load factor is about 45 per cent. If the size of plant is increased, then the lower load factor has a detrimental effect, for it is assumed that there exists no other power market than that represented by the original load curve; on the other hand, if the load factor is increased, then the smaller size of plant raises the cost.

The cost surfaces constructed by this method also facilitate an economic comparison of the various possible sources of power, such as water, coal, and oil.

Thus far we have considered only the case in which a minimum cost per kilowatt-hour for the output of the new plant is the criterion. Suppose a large industrial plant, or a city, were contemplating building a power plant and purchasing whatever amounts of power the new plant could not supply. Then the question becomes: What size plant, operating to partially supply the given load, would make the total annual cost of power (including the cost of purchased blocks) a minimum? The only change required to adapt this method to such a case is in the computation of costs. Instead of adding fixed and operating charges and dividing by the output of the plant, we merely add fixed charges, operating charges, and the cost of purchased power. It is not necessary to perform a division and obtain unit costs, since in this case the divisor would always be the total yearly power demand, and hence the same for all computations. The price curves, however, will represent the total annual power cost instead of the cost per kilowatt-hour.

This method can also be used to determine the economic size of such developments as pumped-storage hydro-electric plants and storage steam plants, by modifying the size ordinates by the computed efficiencies for the various sizes of installation.

Rigidity of Masonry Piers and Walls

By G. D. BURR, ASSOC. M. AM. SOC. C.E.
STRUCTURAL ENGINEER, BUREAU OF ENGINEERING, PUBLIC UTILITIES COMMISSION, SAN FRANCISCO, CALIF.

THE Long Beach earthquake of March 1933 brought forcibly to the attention of the public the need of designing buildings to withstand reasonable lateral forces due to seismic disturbances and high winds. As a result, laws were passed in California requiring lateral-force-resisting construction for most buildings used for human habitation. Such designs require the calculation of the rigidities of wall sections, which is often a laborious task, especially since the deformation due to shear may have as great an effect on the rigidity as the deformation due to bending. This article presents a simplified form for such calculations, and a curve from which the relative rigidities can be read directly.

The distribution of horizontal forces between the various vertical members in a given story is influenced greatly by the relative rigidities of those members. Even if the horizontal force acting in the plane of a wall is known, its distribution among the various columns, piers, and wall sections cannot be determined without a knowledge of the relative rigidities of these vertical elements. Furthermore, these relative rigidities will determine whether horizontal torsional moments will be set up, for even though the center of mass is at the center of the building, such moments will occur unless the center of rigidity is also at that point.

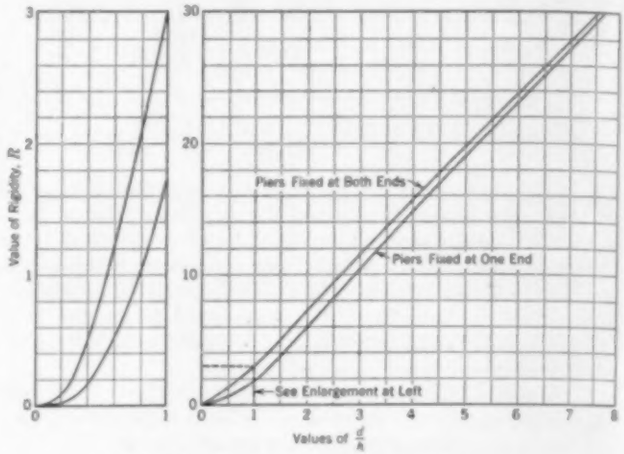


FIG. 1. RIGIDITY OF MASONRY PIERS

In the development of the formulas discussed herein, the following nomenclature applies:

R = rigidity $\left(\text{defined as proportional to } \frac{1}{\Delta}\right)$
Δ_m = deflection due to moment, in inches
Δ_s = deflection due to shear, in inches
$\Delta = \Delta_m + \Delta_s$
E = modulus of elasticity in compression, pounds per square inch
E_s = modulus of elasticity in shear, pounds per square inch
$f = E/E_s$
I = moment of inertia in inches^4 $\left(= \frac{bd^3}{12}\right)$
N = section constant for shear deflection $\left(\frac{1.2}{bd} \text{ for rectangular sections}\right)$
d = width of pier, in inches, in direction of application of force
b = thickness of pier, in inches, at right angles to d
B = same dimension as b, expressed in feet
h = height of pier, in inches
W = horizontal force, in pounds
$\alpha = \frac{d}{h}$ = modulus of rigidity.

For piers fixed at both ends,

$$\Delta = \Delta_m + \Delta_s = \frac{Wh^3}{12EI} + \frac{WhN}{E_s} = \frac{W}{E_s b}\left(\frac{1 + 1.2f\alpha^2}{f\alpha^3}\right)$$

and $$\frac{1}{\Delta} = \frac{E_s b}{W}\,\frac{f\alpha^3}{1 + 1.2\,f\alpha^2}.$$

If now f be taken as 2.5, and since R may be taken as equal to $\frac{W}{\Delta EB}$ (in which B is the pier thickness expressed in feet instead of inches), then $R = \frac{12\alpha^3}{1 + 3\alpha^2}$.

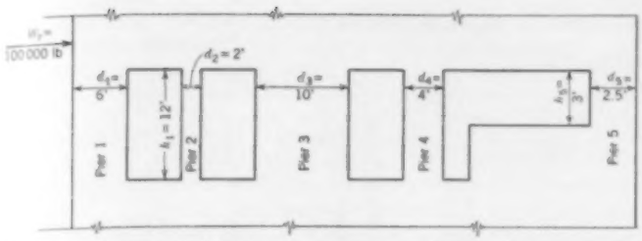


FIG. 2. MASONRY WALL INVESTIGATED FOR STRESS DISTRIBUTION IN TABLE I

All Piers Are 1 Ft Thick

Similarly, for piers fixed at one end only, $R = \dfrac{12\alpha^3}{4 + 3\alpha^2}$.

The formulas just derived are plotted in Fig. 1. It should be noted that they are applicable only to members of rectangular section, and the numerical coefficients are based on a modulus of elasticity in shear equal to 0.4 of that in compression. This is a reasonable value to use for brick masonry, and no great error in force distribution will be introduced if the same relationship be used for concrete. However, it would be a simple task to plot a similar curve for use with concrete if it were desired to use other relative values of the modulus of elasticity in shear relative to that in compression. If a structure is either entirely of concrete or entirely of brick, the relative rigidities of the various piers as read from the curve may be used directly to calculate horizontal force distribution between the vertical members. However, if both concrete and brick piers are found within the same system, the relative rigidities of the concrete piers as read from the curve must be multiplied by the ratio of the modulus of elasticity of concrete to that of brick before the distribution can be computed.

As a simple illustration of the use of the curves, let us compute the distribution of a horizontal load of 100,000 lb among the piers of the brick wall section of Fig. 2. The steps in the computation are shown in Table I. Values of α are first computed and the corresponding values of R are read from the curve. The distribution can now be computed, for the load taken by any pier is to the total load as the R of that pier is to the sum of the R's of all the piers. Unit shears are computed by ordinary methods.

TABLE I. DISTRIBUTION OF HORIZONTAL LOAD AMONG THE PIERS SHOWN IN FIG. 2

FUNCTION	PIER 1	PIER 2	PIER 3	PIER 4	PIER 5
h	12.0	12.0	12.0	12.0	3.0
d	6.0	2.0	10.0	4.0	2.5
α	0.5	0.167	0.833	0.33	0.833
R	0.86	0.05	2.25	0.33	2.25
W (in lb)	15,000	900	39,200	5,700	39,000
Unit shear $= \dfrac{3}{2}\dfrac{V}{A}$ (lb per sq in.)	26	5	41	15	163

The form of the equations assists in giving a clear mental picture of relative lateral shearing force distribution between the piers of a wall by inspection, and thus in checking a design only the obviously most highly stressed piers need be investigated. It will be noted that the shape of the piers determines the proportion of the lateral force taken by each. For example, if two piers forming a wall of uniform thickness are placed between an upper and lower rigid element and subjected to shearing forces between the elements, each pier will take one-half of the shearing force if both are square in elevation, even though one is 2 ft high by 2 ft wide and the other is 20 ft high by 20 ft wide.

It will also be noted that the rigidities of piers vary approximately as the cube of the value of α for slender piers such as columns, and approximately as the first power of the value of α for piers wider than their height. Another interesting fact is that, for piers much wider than twice their height, it makes little difference in their rigidity whether they are fixed at both ends or at one end only.

The actual deflections of piers may also be readily calculated by means of the values of the rigidities taken from the curves. For example, assume the deflection due to shear and flexure is desired for a masonry pier 12 ft high, 3 ft wide, and 2 ft thick, fixed at one end only and subjected to a lateral force of 8,640 lb. The value of α, or d/h, is 0.25. From the curve, $R = 0.0448$. Then

$$\Delta = \frac{W}{REB} = \frac{8{,}640}{0.0448 \times 1{,}000{,}000 \times 2} = 0.0964 \text{ in.}$$

The steps in the analysis of a masonry structure to determine the effects of horizontal torsion are best illustrated in an elementary example. In Fig. 3 is shown a plan of a simple masonry building assumed to be acted upon by a lateral force of 50,000 lb through the center of gravity. The plan dimensions are shown on the figure. Walls are 8 ft high from sill to lintel and 10 ft high from ceiling to floor. All piers are fixed at top and bottom.

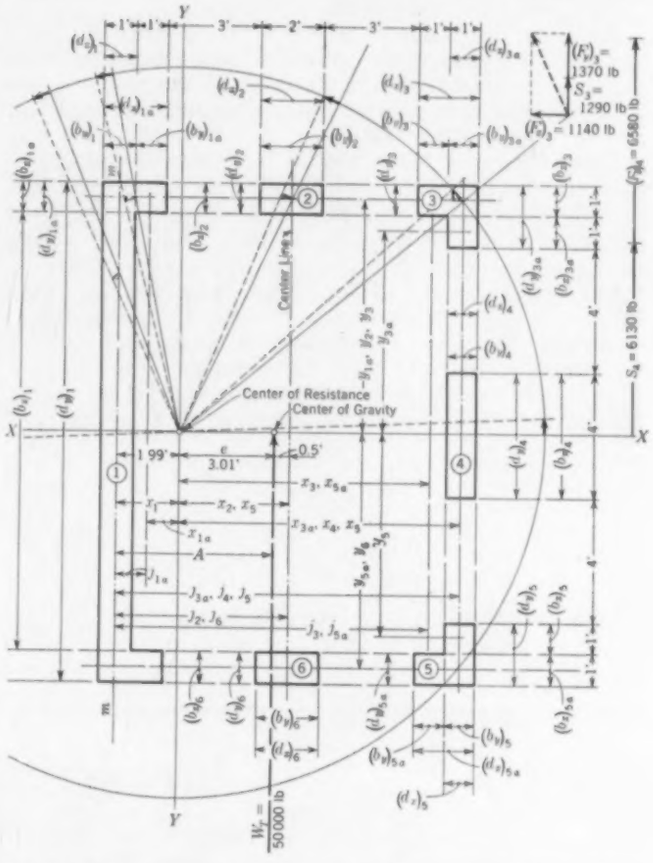


FIG. 3. DETERMINING THE EFFECTS OF HORIZONTAL TORSION IN A MASONRY STRUCTURE

The Necessary Computations Are Shown in Table II

In addition to the nomenclature already given, or obvious from the diagram, the following symbols are introduced:

$(R_y)_4$ = rigidity of Pier 4 in direction Y-Y.

j_4 = distance from moment line m-m to center of Pier 4

TABLE II. TABULATED COMPUTATIONS FOR ILLUSTRATIVE PROBLEM (REFER TO FIG. 3)

FOR DIRECTION Y-Y

PIER No.	b_y (in.)	d_y (ft)	h_y (ft)	α_y	R_y	S_y (lb)	j	$R_y j$	x	x^2	$R_y x^2$	F_y (lb)	$F_y x$ (lb-ft)
1	12	16	10	1.600	5.665	40,480	0	0	1.99	3.96	22.42	9,600	19,100
1a	24	1	10	0.100	0.024	170	1.0	0.024	0.99	0.98	0.02	20	20
2	24	1	8	0.125	0.045	320	5.5	0.248	3.51	12.32	0.56	135	470
3	12	1	8	0.125	0.023	160	10.0	0.230	8.01	64.16	1.48	160	1,280
3a	12	2	8	0.250	0.158	1,130	11.0	1.738	9.01	81.18	12.82	1,210	10,900
4	12	4	8	0.500	0.858	6,130	11.0	9.438	9.01	81.18	69.60	6,580	59,300
5	12	2	8	0.250	0.158	1,130	11.0	1.738	9.01	81.18	12.82	1,210	10,900
5a	12	1	8	0.125	0.022	160	10.0	0.220	8.01	64.16	1.41	150	1,200
6	24	1	8	0.125	0.045	320	5.5	0.247	3.51	12.32	0.56	135	470
Total					6.998	50,000		13.883			121.69		103,640

FOR DIRECTION X-X

PIER No.	b_x (in.)	d_x (ft)	h_x (ft)	α_x	R_x	S_x (lb)	y	y^2	$R_x y^2$	F_x (lb)	$F_x y$ (lb-ft)
1	168	1	10	0.100	0.168	0	0	0	0	0	0
1a	24	2	8	0.250	0.316	0	7.5	56.25	17.78	2,020	15,150
2	12	2	8	0.250	0.158	0	7.5	56.25	8.88	1,010	7,570
3	12	2	8	0.250	0.158	0	7.5	56.25	8.88	1,010	7,570
3a	12	1	8	0.125	0.023	0	6.5	42.25	0.97	130	840
4	48	1	8	0.125	0.090	0	0	0	0	0	0
5	12	1	8	0.125	0.022	0	6.5	42.25	0.95	130	840
5a	12	2	8	0.250	0.158	0	7.5	56.25	8.88	1,010	7,570
6	12	2	8	0.250	0.158	0	7.5	56.25	8.88	1,010	7,570
Total					1.251				55.22		47,110
Grand total									176.91		150,750

e = eccentricity = $A - \dfrac{\Sigma(R_y j)}{\Sigma R_y}$

M = torsional moment = $W_T e$

S_4 = direct shear on Pier 4 due to force W_T

x = distance to center of pier from center of rotation in the direction X-X

$(F_y)_4$ = shearing force, due to torsion, on Pier 4 in the direction Y-Y

The position of the center of resistance is first calculated as shown in Table II by taking the moments of the pier rigidities in the direction Y-Y about the line m-m. Values of b, d, and h are taken from the plan; values of α may be calculated mentally; values of R may be taken from the curve of Fig. 1; and values of $\Sigma R_y j$ and ΣR_y may be obtained by adding the appropriate columns. Having determined the amount of the eccentricity (3.01 ft) and the corresponding moment (150,500 lb-ft), the shear in the individual piers due to torsion is obtained from the following relationships:

$$F_y = \frac{MR_y x}{\Sigma(R_y x^2 + R_x y^2)}$$

$$F_x = \frac{MR_x Y}{\Sigma(R_y x^2 + R_x y^2)}$$

These formulas are based on the assumption that the floors are sufficiently rigid so that all points undergo the same angular motion about the center of resistance. As a check on the work, the summations of the values of $F_y x$ and $F_x y$ should equal the torsional moment. The minor discrepancy in the tabulated values may be charged to slide-rule computations.

The total shear on each pier or wall section is the resultant of the direct and torsional shears. See Fig. 3 for graphical illustrations. Moments resisted by the piers, together with the resulting pier flexural stresses, can likewise be calculated directly from the pier shears. From Table II it will be observed that Pier 4 is the most highly stressed in shear, and Piers 3 and 5 are the next most highly stressed. Pier 4 is therefore likely to be the first to fail under the conditions given, and should be investigated first.

It is recognized that it is not strictly correct to split the non-rectangular corner piers (Piers 1, 3, and 5) into assumed component parts. It is also recognized that for long piers, such as Pier 1, there is an appreciable moment of resistance in the direction X-X near the ends, as well as the principal resistance in the direction Y-Y. However, it will be found that in most practical cases the errors inherent in the method just described are on the side of safety—that is, the results indicate forces slightly too large rather than too small. Furthermore, the accuracy of these results is well within the practical limits of accuracy set by other variables inherent in the construction of masonry buildings.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Comments on Changes in Membership Grades

TO THE EDITOR: Referring to the subject of changes in membership grades in the Society—regardless of the very few who are presumably opposed to such—it seems to me that the very action of the Board of Direction, the vote of the corporate membership, and their general feeling, are sufficient to even the unprofessional or disinterested laymen to make it quite apparent that the present membership classification is today not truly representative and should be changed to assure justice to the Society personnel as a whole.

If I may be permitted, I would suggest the following membership classification, which I believe would be more in accord with present times, and would still be in keeping with the distinctly American organization which we represent. The term "Fellow" apparently does not fit.

First of all, I would wholly and completely eliminate the grade of "Associate Member," because as a matter of fact there is no such thing in our Society. In reality, a so-called "Associate Member" is ipso facto a full Member, being entitled to all of the privileges that a Member has. Moreover, a great many of our "Associate Members" are distinctly modern and up-to-date engineers, in many cases holding and efficiently executing positions of high responsibility and trust. To me they are in reality Members, and I feel they should have said title, instead of the meaningless and erroneous title of "Associate Member." There are many Associate Members who have belonged to the Society for a great many years well worthy of promotion to the grade of Senior Member, and they might receive their advancement by virtue of their outstanding record and ability without having to pass through the grade of Member, at the discretion of the Board of Direction.

I would suggest the following classification: (1) Affiliate (to remain as is); (2) Honorary Member (to remain as is); (3) Senior Member (to include all members of outstanding ability who have held the grade of Member for 5 years, the same to be determined by the Board of Direction; and also to include all other Members who have held the grade of Member for 10 years); (4) Member (to include all other Corporate Members and all Associate Members, it being understood that all Members will be advanced to the grade of Senior Member as soon as they comply with the requirements for said grade); (5) Junior Member (to remain as is, except they be given the right to vote); (6) Student Member (to remain as is).

As to dues, an equitable due for Members and Juniors could be arrived at; and perhaps the dues for Senior Members might be set at not to exceed $25 per annum.

To me such a simple and practical classification appears equitable and just, because it gives to those eminent engineers as well as to other members of long and faithful connection with the Society the advancement to which they are entitled. It also gives to the Junior Member a voice in the organization of which he is a part, and it wholly eliminates the meaningless title of "Associate Member" and permits the so-called "Associate Member" to say, "Yes. I am a full Member of the American Society of Civil Engineers."

FREDERICK E. LEEFE, M. Am. Soc. C.E.
U. S. Assistant Engineer, U. S. Engineer Office

Portland, Ore.
March 7, 1936

TO THE EDITOR: May I express my whole-hearted endorsement of the letter by J. C. Stevens in the February issue of CIVIL ENGINEERING, in which he expresses his feelings regarding the recent suggested changes in membership grades.

I cast my vote against the proposed change because I felt that advancement by regular progression of the members is the most healthful arrangement for the Society. I served my time as an Associate and feel that I am entitled to the honor of Member because of service and effort in my profession.

I do not like the designation Fellow and have no desire to be so classified, but I do like the term Senior Member and trust that in time I may be eligible for that distinction.

F. W. SLATTERY, M. Am. Soc. C.E.
Engineer

Farmington, N. Mex.
March 10, 1936

Diagram for Williams-Hazen Formula Not New

DEAR SIR: My attention has been called to a diagram for the solution of the Williams-Hazen formula, presented by Allan T. Ricketts, M. Am. Soc. C.E., in the February issue of CIVIL ENGINEERING. Mr. Rickett's diagram, in principle at least, is not new, for a similar chart, gotten up for my father by Clinton L. Bogert, M. Am. Soc. C.E., was published in our *Pocket-Book* in 1909. There are differencesin the diagrams—such as differences in limits, and in the method of computing C—but the general aim of each is the same, and each can render practically the same service as the other.

While writing, may I express my strong approval of the way in which CIVIL ENGINEERING refrains from using "second-feet" to express "cubic feet per second." It is right enough to use abbreviations and short cuts when there can be no ambiguity or confusion. We might perhaps do better to use a word that is unmistakably meaningless, such as "cufes" (though I do not urge it for a moment). "Second-feet" looks like something, but does not contain all the units it is meant to refer to, presents the remainder in reverse order, and appears as two multipliers instead of as a rate. Pity the poor student! If we are to interpret "second-feet" as "cubic feet per second," then "acre-feet" may quite as well mean "cubic feet per acre," or "foot-pounds" might mean "cubic pounds per foot," leaving it to Professor Einstein to visualize cubic pounds.

JOHN C. TRAUTWINE, 3d, M. Am. Soc. C.E.
Civil Engineer

Ithaca, N.Y.
February 25, 1936

Geodetic Control for Highway Surveys

TO THE EDITOR: The use of geodetic control for highway surveys, as discussed by J. C. Carpenter, M. Am. Soc. C.E., in the December issue, is of considerable value to the various agencies engaged in surveying and mapping as well as to other organizations that make use of the results or information so secured for many purposes.

The primary question involved in the discussion, however, concerns the practical value of such methods for highway organizations. Unless there is some justification for the possible additional time and expense involved in making the control, it cannot be considered advisable for highway organizations to make use of it. Highway surveys are made basically to determine the choice of route. Other purposes are to secure an economical design, to obtain data for estimating quantities, and to define the land areas required for right-of-way purposes, with the consequent necessity of making land ties. The making of land ties, together with the course or bearing, serves to definitely locate the routing to the legal extent necessary, and is sufficient description for most practical purposes, particularly in rural districts.

A highway survey is generally followed by the construction period, during which the projected routing becomes a physical fact. The highway survey therefore becomes an enduring visible reality across the topography, not an imaginative or visionary line merely marked by points or monuments at infrequent intervals. To this extent, highway, railroad, and kindred types of surveys may be sharply differentiated from the topographical, control, or similar types in that the first group is defined by a physical characterization, whereas the latter group never becomes more than a matter of paper reference for the purpose of comparison or distinction. The first group does not require a reestablishment of the routing for definition, while such reestablishment is essential for the trace of the second.

The control might tend to provide greater accuracy in surveys, but is greater accuracy in present-day practice required? The control would allow the projection of the survey on the triangulation system, but what practical benefit would highway organizations derive from such practice? The control would probably allow the retracing of surveys with greater accuracy and facility, but to what extent is the retracing of surveys practiced by, or required of, highway organizations in the normal routine?

Accuracy of the survey, permanency of the trace, availability of the data secured, and a uniform system of making and recording the survey are factors in the determination of the control to be exercised. The subject, as discussed by Mr. Carpenter, is worthy of study for future policies to be pursued, particularly in regard to the data obtained from the trial project cited.

W. W. ZASS, M. Am. Soc. C.E.
Chief Engineer, State Highway Commission

Little Rock, Ark.
March 7, 1936

Precise Highway Surveys

TO THE EDITOR: A consistent theme runs through the four articles in the symposium entitled "Advances in Surveying Technique," in the December issue. This theme is the economic necessity of precise traverses for highway location center lines.

The great program of mapping recently completed in the Tennessee Valley, as described in this symposium by N. H. Sayford, M. Am. Soc. C.E., was forced to an early completion by the immediate necessity of having accurate plans for the development of flood control and water power. In spite of the remarkable improvements in topographical and cadastral surveying, and the great increase in speed developed in this emergency, the entire program was seriously retarded by lack of surveying control. This is a spectacular example of an occurrence that is all too commonplace in nearly every engineering project, large or small, throughout the country. It is usually the case that modern rapid map-making methods cannot be utilized because of lack of survey control. Thus projects often have to be planned on the basis of inaccurate and inadequate survey information. So important is this preparation of control, that every means must be found to make such controls available.

The greatest surveying agencies in the country are the state and county highway departments. Ordinary highway traverses are continually being run by these agencies; and in his article on "Permanent Value for Highway Surveys Through Geodetic Control," J. C. Carpenter, M. Am. Soc. C.E., has clearly demonstrated that only a very small additional expense is necessary to convert such an ordinary highway survey into a second-order precise traverse, permanently monumented and geodetically controlled. Not to make a highway traverse a precise, permanently marked, geodetically controlled survey, appears to me to be questionable economy.

J. A. C. Callan, M. Am. Soc. C.E., has described the local control surveys which are connected with the U. S. Coast and Geodetic Survey triangulation scheme, and which can be utilized for the control of these highway traverses. He has described the simplified method of utilizing geographical positions by means of plane coordinate systems introduced by the U. S. Coast and Geodetic Survey. With an increase of approximately one-tenth of one per cent in the cost of building highways, every highway survey can be made part of a control survey system, which will enable rapid mapping at almost any scale when the necessity for a map arises, will eliminate much of the confusion and expense entailed in the acquirement of right of way, and will provide for the state geodetically controlled positions and directions with all the advantages they offer.

It will not be long before the public and the courts of law will refuse to recognize the type of description now frequently prepared by highway agencies for the acquirement of land. This type of description ensures the proper width of right of way but fails to locate definitely that right of way, or to describe definitely the land taken from any particular property owner. Such descriptions have been repudiated by the land court in Massachusetts. The highway division in that state establishes monumented second-order traverse to establish the center line.

It appears to me that it would be of value to both engineers and lawyers if the Society could emphasize the economic loss occasioned by establishing surveys for highway location which, due to inaccurate surveying methods or lack of monumentation, are unavailable for accurate property description or control of aerial maps.

PHILIP KISSAM, Assoc. M. Am. Soc. C.E.
Associate Professor of Civil Engineering, Princeton University

Princeton, N.J.
February 22, 1936

Shades Valley Plant a Pioneer in Chemical Precipitation of Sewage

TO THE EDITOR: A considerable amount of pioneering work in the field of chemical treatment of sewage has been done at the Shades Valley plant, described by H. H. Hendon, Assoc. M. Am. Soc. C.E., in the December issue. Some of the results obtained with returned sludge are particularly interesting. It seems to me that one thing has been clearly demonstrated, namely, that the suspended solids in the supernatant liquor decrease rapidly with a volume of returned sludge up to 5 per cent, but that thereafter increasing the volume does not greatly improve results. In the case of a reduction in bio-chemical oxygen demand the decrease is reasonably uniform up to about 20 per cent by volume of returned sludge, and thereafter almost negligible. It has occurred to me that there is a possibility that these results might be changed after a long period of operation and that with the recirculation of even a relatively small quantity of sludge, septic action might occur in the settling tanks.

The reduction in suspended solids, bio-chemical oxygen demand, and turbidity, brought about by varying amounts of chlorinated copperas, has indicated clearly the effective results of small dosages—up to 10 or 15 per cent of the amount required for complete flocculation—and the proportionately smaller effects of larger amounts. This again demonstrates the value of this method of sewage treatment where varying degrees of purification are essential at various seasons of the year or for short periods of time during any particular season.

The cost of chemicals at Shades Valley to produce the average operating results shown by Mr. Hendon for the four-month period from June 1 to October 1, 1935, is remarkably low, and makes the total cost of operation per million gallons compare favorably with the best costs for other methods. It is much less than the cost of most other methods producing comparable results.

A. CLINTON DECKER, M. Am. Soc. C.E.
Sanitary Engineer, Tennessee Coal, Iron and Railroad Company

Birmingham, Ala.
February 21, 1936

Unsymmetrical Loads May Have Important Effects on Box Conduits

TO THE EDITOR: I have read with interest the article by Leonard L. Longacre, Assoc. M. Am. Soc. C.E., in the January issue.

Unfortunately, the data as presented in this article are not complete. Design requirements for maximum moments with moving live load often necessitate investigating unsymmetrical loadings. If the slope-deflection method is used there result five unknowns for the single span box and eight for the double box—six joint equations, one horizontal bent and one vertical bent equation.

The data given by the author for two-span boxes are of value for special cases only, since "vertical sway" is not taken into account. I have found that under certain loading conditions the effect of unbalanced girder shears is very important.

For readers not familiar with the steps of design for closed conduits, the following suggestions are made:

1. If the slope-deflection solution is used, set up one table of general equations, omitting the effect of girder shears and equating the right-hand terms to $X_1, X_2, \ldots X_n$. The solution of these equations will give moments at all points as coefficients of $X_1 \ldots X_n$. Evaluate the moments in terms of the loadings and compute the girder shears. If these do not balance, take the excess shear at each column and determine new values of $X_1, \ldots X_n$ by inspection of the original equations. This process is exact, and not a mere approximation. The increments of moments found by means of these new values of $X_1, \ldots X_n$ are the corrections to be added to the original moments. This procedure makes one solution serve for all purposes.
2. If the solution is by the moment distribution method or the method of restraints, determine moments at all points, assuming no horizontal or vertical deflections; then correct for horizontal deflection, and finally for vertical deflection.

L. T. EVANS, Assoc. M. Am. Soc. C.E.
Consulting Structural Engineer

Long Beach, Calif.
March 5, 1936

Editor's Note: Although Mr. Longacre's article as published was limited to the condition of uniform loading, he also furnished data on a typical case of non-uniform loading and presented a tabular arrangement of the slope-deflection equations.

Economical Method of Garbage Disposal in St. Louis

TO THE EDITOR: The article on "The Disposal of Garbage with Sewage" by C. E. Keefer, M. Am. Soc. C.E., in the March issue, calls to mind the experience of the city of St. Louis in garbage disposal. Previous to the spring of 1935 the garbage from the city of St. Louis was disposed of by hog feeding under private contract. Public sentiment against the nuisance finally resulted in a court injunction restraining the city from continuing this method of disposal.

In the summer of 1934 the city conducted experiments with the grinding of garbage and its disposal by means of the city sewers. The experimental grinder installed was of the hammer-mill type, electric-driven, with a capacity of 10 tons per hr. The mechanical features proved satisfactory, and due to the characteristics of the combined sewers into which the ground garbage was discharged, no difficulties were encountered from this source.

Meager information concerning the bio-chemical oxygen demand of garbage and the present degree of pollution of the Mississippi River at St. Louis handicapped conclusions as to the effect on the river. However, after a study of all available data, I concluded that, assuming mean conditions of river flow and garbage quantities, the additional oxygen demand of the ground garbage would be even less than the probable errors involved in making such analyses.

The U. S. Bureau of Fisheries rendered an adverse report on the proposed method, based largely on its conclusion that the organic content of the ground garbage would at times reduce the dissolved oxygen reserve in the river to a critical level. But the army engineers, after considering various reports and making observations, approved this method of disposal at St. Louis.

Following these preliminary steps a plant, consisting of a grinder of 20-ton hourly capacity, storage hoppers, conveyors, and building was constructed. The plant is located on the edge of an industrial area. With the grinders operating at full capacity the effluent, including the dilution water, amounts to about 400 gal per min. It is discharged into a combined street sewer, 8.5 ft in diameter, with an average dry-weather flow of approximately 8,000 gal per min. This latter sewer discharges within 1,200 ft into a 15 by 20-ft sewer with an average dry-weather flow of approximately 50,000 gal per min. About two miles farther on, this trunk line discharges into the Mississippi River.

Present indications point to a cost of about 30 to 35 cents per ton for this method of disposal. This estimate includes labor, maintenance, water, light, heat, and power. At this time plans are being made for an additional plant, located at a strategical point, in order to provide additional capacity and further reduce the haul.

Due to the construction and careful maintenance of the plant as well as the short time garbage is held before final disposal, there has been no odor nuisance. Such odors as have occurred occasionally during warm months have been successfully controlled by sprinkling garbage in the hoppers with a specially prepared deodorant.

The experience of St. Louis to date seems to justify the assumption that, under certain favorable conditions—important among which are the characteristics of the sewer system and the receiving stream—this method of garbage disposal is practical, economical, and sanitary. However, before adopting it a municipality should have a competent engineer make a thorough study and survey of the local situation. There are many factors other than the design details of the grinding equipment that must be taken into consideration before deciding as to the feasibility of the method for any particular city.

Acknowledgment for the data in this discussion is made to Frank J. McDevitt, director of streets and sewers, who planned and supervised the installation of this new method of garbage disposal in St. Louis.

W. SCOTT JOHNSON, M. Am. Soc. C.E.
Sanitary Engineer, St. Louis Department of Health

St. Louis, Mo.
March 4, 1936

Planning and Work Relief

TO THE EDITOR: Apropos of the article on planning under work relief by Harold M. Lewis, M. Am. Soc. C.E., in the March issue, I should like to comment on the county planning problem. Under the work relief set-up, county planning has run a difficult obstacle race, and to date after more than two years it still has its back to the wall and is continuing to fight for recognition. Although there is some hope for the approval of county planning projects, the present situation leaves much to be desired for the carrying out of a comprehensive program. With the approval of such a project assured, its satisfactory operation is questionable, because of the endless red tape surrounding all projects classified as statistical.

The creation of CWA and the opening of its doors to planning projects offered new life to the county planning program. In spite of the hasty organization of this program, frequent interruptions, and its short duration, the results obtained were sufficient to prove that it was worth while. Practically all the projects concerned themselves with the first step in the development of a planning program—the collection of basic facts pertaining to the area under study. Under CWA obtaining trained personnel was in general not a difficult proposition. Those employed consisted of engineers, architects, draftsmen, statisticians, and similar professional groups.

The appearance of TERA (Temporary Emergency Relief Administration), the successor of CWA, gave an entirely new outlook to the carrying on of a planning program and, for many counties, created an insurmountable barrier. The counties that were able to carry on under the new regulations did splendid work and added a great deal of basic information to that secured under CWA. Under TERA, the qualifying phrase for work, "eligible for home relief," found few if any technical and professional people available in the rural areas, and made the operation of a county planning project a difficult one.

With the arrival of WPA, a new organization to take over the functions of TERA, the situation became more complicated than ever. Mr. Lewis has adequately outlined the main difficulties encountered. It is of interest to note, however, that up to January 1, 1936, no county planning project was yet in operation in the state of New York, although projects for Erie, Nassau, Niagara, and Westchester counties had been approved by the Federal Coordinating Committee. The prospect of an adequate staff under WPA, even though the projects were approved, is not bright. The available technical men and those with adequate training have already been assigned to other projects which received early approval and are now in operation.

I believe there is justification for the wide range of work-relief projects included under the classification of planning. County government has become complex and covers many fields of public administration. The various departments are already overloaded with detail, and yet there is a continuous stream of requests for information, not only from the county officials, but from the general public. To furnish this information requires time and personnel taken from regular work. One of the functions of planning is "fact finding." It is my opinion that this function might well be enlarged to the end that all pertinent data relative to the county, its resources, its government, and similar facts be centralized in the planning board. Thus it would be readily available to the departments and the public, and the planning board would become a clearing house for all information. Here is created another activity to justify a planning board, and more opportunity for work relief that cannot qualify for the more technical phases of planning. Realizing the limitations of work relief, every county should thus concentrate on those problems that have any future bearing upon the county development, and leave the actual development of the plan to some later date.

The conclusion that may be drawn is that, in general, the use of work relief for the technical part of county planning is very limited, particularly in those counties which are predominantly rural in character. In the metropolitan counties and in the counties with second-class cities, where there is a large number of technical and professional people available for work relief, greater opportunities exist and the program of planning may be further advanced.

HAROLD E. DEAN, M. Am. Soc. C.E.
Consulting Engineer

Poughkeepsie, N.Y.
March 6, 1936

Comment on Schedules Promulgated by Society's Salary Committee

DEAR SIR: I wish to compliment Mr. Goodrich of the Committee on Salaries for the excellent report appearing in the March 1936 issue of CIVIL ENGINEERING. The report speaks for itself and is evidence of an exceptional amount of arduous work on the part of the members of the Committee.

I wish also to compliment John C. Hoyt, M. Am. Soc. C.E., for his article on the "Classification and Compensation of Federal Engineering Positions" and to express hearty concurrence in his conclusion that "an adequate classification is essential to the satisfactory operation of civil service laws, and it is also basic in the selection of suitable personnel for various positions and in the fixing of an equitable compensation for their services. It provides a logical and effective means for the proper classification of positions, both within organizations and between organizations, which is essential for the equitable consideration of all questions having to do with employment." Further, that "these subjects are coming to be of more and more importance in determining the economic standing of the engineer, and it is highly desirable that they be standardized and that all engineers become fully informed in regard to them."

Mr. Hoyt does not claim that the federal system is the final answer, but he points out that it is agreed by all who have had anything to do with the federal classification that it has done much to improve conditions of men holding technical or other positions in the government service, and it has also been of great benefit to the service.

It is therefore my strong recommendation that the Board of Direction arrange for a thorough study of the federal and related classification systems to the end that our Society at an early date may take the lead in promoting a classification of engineering positions appropriate for application to engineering employment, both in public and private service.

The objective of such a classification would be to provide a logical and effective means for the study of positions, both within and between organizations, as an essential aid in the equitable consideration of all employment questions. As further set forth by Mr. Hoyt, such a classification would provide a basis for eliminating much of the confusion which results from the use of inaccurate payroll and other titles in the consideration of employment questions, a sound foundation for establishing pay scales, and an equitable means for the comparison of positions involving independent work with those involving administrative duties.

The federal classification, which has been in operation for over ten years and is now applied to about 25,000 professional and scientific positions, including about 10,000 engineers, has been of material help in improving employment conditions in the federal government.

THOS. E. STANTON, JR., M. Am. Soc. C.E.

Sacramento, Calif.
March 14, 1936

DEAR SIR: The report by the Salary Committee and the article by John C. Hoyt, M. Am. Soc. C.E., published in the March issue of CIVIL ENGINEERING, bring again to mind the reports by the Salary Committee published in the April 1934 and August 1934 issues of CIVIL ENGINEERING. An element of confusion has surrounded the purpose of these two earlier reports, which it is believed will not be removed until the Board of Direction takes some action to put the record straight.

Several members of the Board have stated that they approved the original report for publication in the understanding that it was intended to use the salary schedule which it contained as a guide for fixing the salaries of civil engineers, then engaged on relief work, who were receiving pitifully low salaries. This point was discussed at the July meeting of the Board of Direction at Vancouver, B.C., in July 1934, and some of those at least who were in attendance came away with the understanding this was the true purpose. Nevertheless, this original report opened with the unfortunate statement that "This report is an effort to determine from statistical data the salaries appropriately to be paid to Civil Engineers" and there has never been any official denial by the Board of Direction that this was the true purpose.

Discussion of the matter which followed publication of the original report led to elimination of the above quoted statement as to purpose from the revised report presented to the Board at the Vancouver meeting, and to some other revision including the addition of another grade to the personnel classification and an increase in the top salary from $5,700 to $6,100 per annum. However the implication has more or less persisted that the salary schedule presented was suitable for determining the salaries of professional engineers generally, whereas as a matter of fact it was derived from the prevailing rates of pay then in effect among some 16,000 highway engineers who admittedly were receiving less than the average for the whole group of salaried professional engineers.

TABLE I. ENGINEERING PERSONNEL CLASSIFICATIONS AND SALARY SCHEDULES

Sponsor	No. Grades	Annual Salaries
Salary Committee Am. Soc. C.E. (Apr. 1934)	6	$1,500–$5,700*
Salary Committee Am. Soc. C.E. (Aug. 1934) (May 1935)	7	$1,200–$6,100*
Council Assoc. Prof. Eng. British Columbia	9	$600–$7,200+†
U. S. Personnel Classification Board	9	$2,050–$10,000+‡

Notes: * These represent the median salaries prevailing in the lowest and highest grades ranging from engineering assistant to chief engineer.

† These represent the lowest salary in the lowest subprofessional grade and the lowest salary in the grade of Assistant Chief Engineer with the upper limit of the latter grade marked "no limit" and nothing shown for the grade of Chief Engineer. (Taken from 1935 Year Book of the Engineering Profession in British Columbia.)

‡ This refers only to the professional and scientific service and does not include the subprofessional.

This places the American Society of Civil Engineers, the membership of which is perhaps 90 per cent in the salaried class, in the unfortunate position of having promulgated a salary schedule based upon the prevailing salaries of a group of engineers receiving less than the average of all salaried engineers and this too in a depression period.

The Salary Committee has done some excellent work in assembling information as to personnel classification and prevailing rates of pay, particularly as exhibited in its latest report first referred to above. There are, however, noteworthy differences between the salary schedules which it has proposed and those proposed by the Executive Council of the Association of Professional Engineers of British Columbia and the U. S. Personnel Classification Board, both of which agencies have made most exhaustive studies of this matter. These differences are indicated in the accompanying Table I.

It is believed the Board of Direction should officially declare the true purpose of the salary schedules promulgated by the Salary Committee was to afford a basis for determining appropriate salaries for engineers engaged on relief work rather than for salaried professional engineers generally and that unless and until this is done these schedules will continue to embarrass the profession.

EVERETT N. BRYAN, M. Am. Soc. C.E.
Chairman Salary Committee, Sacramento Section of the Society

Sacramento, Calif.
March 10, 1936

Editor's Note: In connection with the publication in "Civil Engineering" of letters expressing opinions on or critical of the Society or its activities, it is the established policy that such expressions be accompanied by comment by the chairman of the administrative unit involved. As regards the subject here under discussion, however, E. P. Goodrich, Chairman of the Committee on Salaries, believes it desirable that Society members have as thorough an understanding of its details and implications as possible, and accordingly favors the immediate publication of the accompanying letters. Mr. Goodrich will defer the comments normally to be expected from him until a later issue.

Spring Meeting in Hot Springs, Ark.

Arlington Hotel to Be Headquarters for Gathering, April 22–25, 1936

Opening Session

WEDNESDAY—April 22, 1936—MORNING

9:00 **Registration**

10:00 **Spring Meeting called to order by**

GEORGE R. CLEMENS, *President, Mid-South Section, Am. Soc. C.E.; Senior Engineer, Mississippi River Commission,* Vicksburg, Miss.

Addresses of Welcome

THE HONORABLE LEO P. MCLAUGHLIN, *Mayor of Hot Springs,* Ark.

THOMAS J. ALLEN, JR., *Esq., Superintendent, Hot Springs National Park,* Hot Springs, Ark.

Response

D. W. MEAD, *President, American Society of Civil Engineers, Consulting Engineer; Professor Emeritus, Hydraulic and Sanitary Engineering, University of Wisconsin,* Madison, Wis.

10:30 **The Engineering Problems of the Lower Mississippi Basin and Their Importance to the Country as a Whole**

GROVER T. OWENS, *Esq., President, Little Rock Chamber of Commerce,* Little Rock, Ark.

General Meeting

WEDNESDAY—April 22, 1936—AFTERNOON

DONALD H. SAWYER, *Vice-President Am. Soc. C.E.,* Presiding

2:30 **Industrial Development of the Lower Mississippi Basin**

H. C. COUCH, *Esq., President, Arkansas Power and Light Company,* Pine Bluff, Ark.

2:50 **The Future of the Railroads in the Mississippi Valley and the Southwest**

L. W. BALDWIN, *M. Am. Soc. C.E., President, Missouri Pacific Railroad,* St. Louis, Mo.

3:10 **Oil and Gas Resources of the Mid-South and Their Effect Upon Future Development**

COL. T. H. BARTON, *President, Lion Oil Refining Company,* El Dorado, Ark.

3:30 **The Undeveloped Resources of the Mid-South**

EARLE W. HODGES, *Esq., Manager of Public Relations, Cities Service Company,* New York, N.Y.

3:50 **Discussion**

© Hot Springs Chamber of Commerce

AIRPLANE VIEW OF OLDEST NATIONAL PARK
Hot Springs National Park, Arkansas

© Hot Springs Chamber of Commerce

STREET SCENE, HOT SPRINGS, ARK.
One of America's Noted Resort Cities

WEDNESDAY—April 22, 1936—EVENING

7:00 **Dinner Dance**

Ball Room, Arlington Hotel.

Toastmaster—E. HARTLEY WOOTTON, *President, Hot Springs Chamber of Commerce,* Hot Springs, Ark.

Address—"The Sucker," by H. T. HARRISON, *Attorney, Rock Island Railway Company,* Little Rock, Ark.

During the dinner there will be a number of entertainment features.

Dancing 10:00 to 1:00.

Tickets for the dinner and evening's entertainment are $3.25 each. Tickets for Juniors, for the dance only, are $1.00 per couple.

© *Corps of Engineers, U. S. Army*

LOWER PORTALS, DIVERSION TUNNELS, FORT PECK DAM

© *Corps of Engineers, U. S. Army*

DIVERSION TUNNEL CONSTRUCTION, FORT PECK DAM

Sessions of Technical Divisions Occupy Entire Day

THURSDAY—April 23, 1936—MORNING

SANITARY ENGINEERING DIVISION

10:00 Unique Features of the Hot Springs Sewage Treatment Project

ELLSWORTH L. FILBY, *Assoc. M. Am. Soc. C.E., Assistant Engineer, Black and Veatch*, Kansas City, Mo.

10:30 Recent Developments in Malarial Control in the Mid-South

COL. J. A. LEPRINCE, *Senior Sanitary Engineer, U. S. Public Health Service*, Memphis, Tenn.

11:00 Recent Developments in the Construction of Water Works Projects in the Mississippi Valley and the Mid-South

CHARLES B. BURDICK, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

11:30 Discussion

WATERWAYS DIVISION

10:00 Improvement on Lower Mississippi River

HARLEY B. FERGUSON, *Brigadier-General, Corps of Engineers, U.S.A.; President, Mississippi River Commission*, Vicksburg, Miss.

10:40 Improvement on Missouri River

E. O. WALSH, *Captain, Corps of Engineers, U.S.A.; Division Engineer*, Kansas City, Mo.

11:20 Discussion

THURSDAY—April 23, 1936—AFTERNOON

WATERWAYS DIVISION

2:30 Waterway Transportation

RUFUS W. PUTNAM, *M. Am. Soc. C.E., President, Maritime Engineering Corporation; Consulting Engineer*, Chicago, Ill.

3:10 Discussion opened by

S. L. WONSON, *M. Am. Soc. C.E., Assistant Chief Engineer, Missouri Pacific Railroad*, St. Louis, Mo.

General Discussion

CONSTRUCTION DIVISION

2:30 Construction Features of the Fort Peck Project

T. B. LARKIN, *M. Am. Soc. C.E., Major, Corps of Engineers, U.S.A.; District Engineer, Fort Peck District*, Fort Peck, Mont.

3:00 Construction Features of the Conchas Dam

GERARD H. MATTHES, *M. Am. Soc. C.E., Member of Consulting Board for Conchas Dam; Principal Engineer, Office of President, Mississippi River Commission*, Vicksburg, Miss.

3:30 Construction Features of the Mississippi River Bridge at New Orleans

N. F. HELMERS, *Esq., Vice-President, Siems-Helmers, Inc.*, St. Paul, Minn.

4:00 Discussion

SINKING THE MATTRESS FOR A PIER, MISSISSIPPI RIVER BRIDGE

COUNTRY CLUB SCENE AT HOT SPRINGS, ARK.

Entertainment for the Ladies

WEDNESDAY April 22, 1936—MORNING AND AFTERNOON

During the morning the visiting ladies will register at Ladies' Headquarters and will be entertained at informal receptions by the members of the Ladies Committee.

In the afternoon the ladies will be the guests of the Ladies Committee. Entertainment will be provided in the form of sightseeing trips followed by a tea.

THURSDAY—April 23, 1936—MORNING AND AFTERNOON

During the morning, visiting ladies will be taken on a sightseeing trip followed by a luncheon and bridge in the afternoon.

For those who enjoy riding, there will be saddle horses available and the country club will be open to the visiting engineers and their ladies every day of the meeting.

Boating and fishing parties may be arranged if desired.

THURSDAY—April 23, 1936—EVENING

7:30 A Program of Entertainment Has Been Planned for Members, Ladies, and Guests, at One of the Nearby Clubs

Dinner will be followed by dancing.

Tickets for the dinner and evening's entertainment will be $1.50 each.

©Hot Springs Chamber of Commerce

Miles of Bridle Paths

©Hot Springs Chamber of Commerce

Mountain Drives Offer Beautiful Vistas

HOT SPRINGS NATIONAL PARK, ARKANSAS

© *Photograph by U. S. Army Air Corps*

YUCATAN BEND CUT-OFF ON THE MISSISSIPPI RIVER BELOW VICKSBURG

All-Day Excursion on Friday

FRIDAY—April 24, 1936

8:00 All-Day Excursion by Special Train and Boat to the Recently Completed Mississippi River Cut-Offs to Eliminate the Famous Greenville Bends

These cut-offs shorten the river by 30 miles in a previous length of 40 miles through this reach.

The party will leave Hot Springs by special train at 8:00 a.m., arriving in Arkansas City about noon, going thence to the boat, where luncheon will be served.

After inspection of the cut-offs, the party will disembark at Lake Village and return to Hot Springs by special train about 7:40 p.m.

There will be a dining car on the train where breakfast and dinner will be served if desired.

This trip is contingent upon the purchase of 100 tickets, and will be canceled in case the minimum guarantee cannot be met, other plans being substituted in that event.

Members are urged, therefore, to send in advance registration as early as possible for the guidance of the Local Committee.

The tickets for this trip, including all transportation and luncheon, are $4.50 each.

The Opening Blast

Shortly After the Blast

ASHBROOK CUT-OFF ON THE MISSISSIPPI RIVER A SHORT DISTANCE BELOW ARKANSAS CITY, ARK.

SATURDAY—April 25, 1936—MORNING

9:00 Trip to Bauxite Mine

The party will leave at 9:00 a.m. for the inspection of a bauxite mine about an hour's journey from Hot Springs.

The group will return to Hot Springs about 1:00 p.m., in time for lunch.

There will be no charge for this trip.

Hotel Accommodations and Announcements

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Spring Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in Hot Springs.

Hotel Rates

Hotels	Single Room		Double Room	
	With Bath	Without Bath	With Bath	Without Bath
Arlington Hotel	$3.00 up	.....	$5.00 up	.....
Kingsway Hotel	3.50 up	$2.50 up	5.00 up	$4.00 up
Majestic Hotel	3.00 up	.....	4.00 up	.....
Como Hotel	2.00 up	1.50 up	3.00 up	2.50 up
Howe Hotel	3.50 up	2.50 up	5.00 up	3.50 up

The Arlington Hotel is the meeting headquarters.

Reservations are to be directly with the hotel as early as possible in order to prevent delay and inconvenience in obtaining accommodations on arrival.

All who attend the Spring Meeting are requested to register immediately upon arrival at meeting headquarters. Special badges and tickets will be obtained at the time of registration.

Student Accommodations

Special hotel accommodations will be available to student members provided advance reservations are made with Prof. Dewey M. McCain, Mississippi State College, State College, Miss.

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing any desired information about the city. At the registration desk, a card file of those in attendance will be maintained, with information as to members' hotel addresses in Hot Springs.

Highway Information

Hot Springs is accessible by a complete system of paved roads. Information on routing will be furnished by the Hot Springs Chamber of Commerce, Hot Springs, Ark.

Entertainment

Attention is directed to the program for the entertainment of the ladies. In addition, the ladies are expected to participate in all the other features of the meeting that may interest them.

Members wishing to play golf may make application at the registration desk.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

See page 22 in back of this issue for registration and ticket order forms.

The Arlington Hotel—Spring Meeting Headquarters

Local Section Conference

On Tuesday afternoon, April 21, 1936, there will be a conference of delegates from the 14 Local Sections in the Southern Meeting Region with the Society's Committee on Local Sections and the Southern Region Meetings Committee.

A comprehensive agenda has been prepared for the discussion of activities of mutual interest to the Local Sections.

All interested members are invited to attend and participate in the conference.

Student Chapter Conference

At 2:00 p.m. on Thursday afternoon, April 23, 1936, will be held a conference of representatives from the Student Chapters. In addition to official representatives, as many student members as practicable, together with faculty advisers and contact members, are expected. The conference will be open to discussion of any subjects of interest to the Chapters, and after the meeting an abstract of the proceedings will be sent to every Chapter in the country. Members of Student Chapters are also invited to attend and participate in all the events of the Spring Meeting.

Weather Information

The average temperature in Hot Springs after the first of April is from 65 to 85 F, so that summer clothing will be in order.

Local Committee on Arrangements

George R. Clemens, *General Chairman*

Executive Committee

J. R. Fordyce, *Chairman*

J. H. Haylow — D. A. MacCrea — W. W. Zass

Program Committee

William Parkin, *Chairman*

A. M. Lund — Dewey McCain

Transportation Committee

Roy E. Warden, *Chairman*

N. B. Garver — L. R. Parmelee — Blair A. Ross

Reception Committee

John H. Gardiner, *Chairman*

Eugene F. Bespalow — W. D. Dickinson — L. L. Hidinger

S. L. Davis — W. E. Elam — Frank V. Ragsdale

Ladies Reception Committee

Mrs. J. R. Fordyce, *Chairman*, Hot Springs, Ark.
Mrs. George R. Clemens, *Vice-Chairman*, Vicksburg, Miss.
Mrs. H. C. Couch, *Vice-Chairman*, Pine Bluff, Ark.
Mrs. John H. Gardiner, Fort Smith, Ark.
Mrs. N. B. Garver, Little Rock, Ark.
Mrs. L. L. Hidinger, Memphis, Tenn.
Mrs. R. S. Lander, Little Rock, Ark.
Mrs. William Parkin, Memphis, Tenn.
Mrs. L. R. Parmelee, Helena, Ark.
Mrs. Blair A. Ross, Memphis, Tenn.
Mrs. Roy E. Warden, Little Rock, Ark.
Mrs. W. W. Zass, Little Rock, Ark.

Hot Springs Local Committee

Mrs. W. T. Wootton, *Vice-Chairman*

Mrs. Russy Brown	Mrs. Charles Lutterloh
Mrs. J. H. Chestnut	Miss Bess Martin
Mrs. Garnett Eisele	Mrs. Tom R. Martin
Mrs. George Fletcher	Mrs. W. H. Moncrief
Mrs. John R. Fordyce, Jr.	Mrs. B. L. Neimeyer
Mrs. S. W. Fordyce, III	Mrs. William Porter
Mrs. Charles Garrett	Mrs. Fred Rix
Mrs. Sam Garrett	Mrs. Euclid M. Smith
Mrs. Walter Klugh	Mrs. Ray Smith
Mrs. J. L. Longino	Mrs. Hartley Wootton

The program as a whole has been prepared under the direction of the Southern Region Meetings Committee, Donald H. Sawyer, *Vice-President, Am. Soc. C.E., Chairman;* and E. P. Arneson, L. L. Hidinger, Frederick H. McDonald, Herman Stabler, *Directors, Am. Soc. C.E.*

Please call on the Committee on Local Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Early Presidents of the Society

With this issue, "Civil Engineering" begins a series of brief biographies of the early presidents of the Society. Every effort will be put forth to make these reviews interesting both to the casual reader and the serious student of engineering history, but to achieve this end the cooperation of many persons is necessary. Any one acquainted with personal incidents in the lives of these men, or having photographs of engineering works with which they were connected, is requested to communicate this information to Sydney Wilmot, Manager of Publications. The presidents will be treated in chronological order so that the series this year will include, in addition to James Laurie, the following men: James Pugh Kirkwood, William Jarvis McAlpine, Alfred Wingate Craven, Horatio Allen, Julius Walker Adams, George Sears Green, Ellis Sylvester Chesbrough, and William Milnor Roberts.

Introduction

Interwoven with the stories of the early presidents of the Society is the story of nineteenth century engineering achievement in the United States. It is well, then, to begin this series by sketching briefly the background against which these leaders worked. And in selecting a base for this orientation, the year 1852 suggests itself, by reason of its being the birth year of the Society. In the following paragraphs, no attempt has been made at completeness; rather, a few outstanding events and facts have been selected which seem to typify succinctly the then-existing state of the art. Most of the information has been taken from Kirby and Laurson's *Early Years of Modern Civil Engineering*.

By 1852, the canal had yielded place to a sturdy youngster, the steam railroad. Eighteen years before, the earliest road designed entirely for steam had been built in South Carolina, and soon the iron rails were being laid through forest and over mountain, and a vast network of communication was beginning to take form.

By 1852, also, the arch bridge was being replaced by a variety of forms. Five years before, Squire Whipple had published the first treatise presenting a correct method for calculating truss stresses, and the Fink, Bollman, Pratt, and Whipple trusses were beginning to come into use. Fink's bridge over the Monongahela at Fairmount, W.Va., with three 205-ft spans, was just completed, and John August Roebling was beginning an 821-ft suspension bridge at Niagara Falls. A few years earlier, a plate-girder bridge of 50-ft span had been built on the Baltimore and Susquehanna Railroad.

In 1852, the Francis inward-flow turbine was five years old, and the famous Lowell hydraulic experiments had been under way about two years. On the Mississippi River, Humphreys and Abbott were beginning their famous investigation, and two years before, Congress had authorized the preparation of a comprehensive plan for the control of Mississippi floods. The study resulted in the Ellet report, a pioneer document on flood control engineering in the United States.

The sanitary field was largely undeveloped, but the relation between the prevalence of certain diseases and the pollution of water had been established. In London the Metropolis Water Act, requiring the filtration of water supplied for household use, had just been passed. The most pretentious water supply system of the day in the United States was that of New York; the old Croton Aqueduct, 35 miles in length, had been completed 10 years before. Sewerage systems had not yet been developed to any appreciable extent, but within three years the first comprehensive system would be built—at Chicago, in 1855.

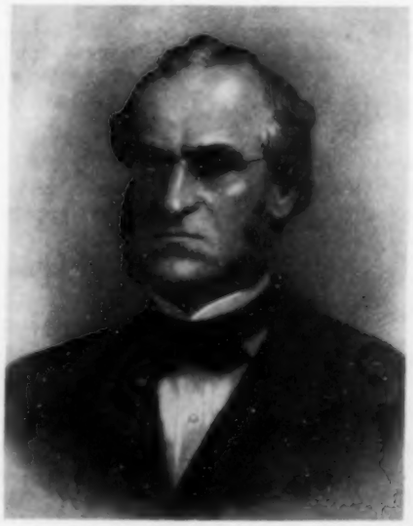
The chief materials of construction, aside from timber, brick, and stone, were still cast and wrought iron and natural cement. But within four years Bessemer would perfect the steel-making process that bears his name. Portland cement, first patented in England in 1824, would be introduced in this country shortly after the Civil War, and at about the same time, the first patents for reinforced concrete would be issued.

Clearly then, in 1852 the stage was being set for "modern" engineering practice along a number of widely varied lines. And with the development then under way, the need for organizing the profession became apparent. In that organization James Laurie played an outstanding part.

I. James Laurie, 1811–1875

President of the Society, 1852–1867

James Laurie was born at Bells Quarry, near Edinburgh, Scotland, on May 9, 1811. Little is known of his early years, except that for a time he was apprenticed to a maker of mathematical and engineering instruments, and later served a year of apprenticeship in the office of a civil engineer in Edinburgh.



James Laurie, First President of the Society

When about 21 years of age, Laurie came to the United States with his friend, James P. Kirkwood, who had been made chief engineer of construction of the Norwich and Worcester Railroad. Laurie was made associate engineer, and when Kirkwood left in 1835 he was appointed to fill the vacancy. The Norwich line was probably the first in this country on which a tunnel was built.

For several years after its completion, Laurie engaged in a miscellaneous engineering practice—railway locations and surveys, dams, bridges, and wharves—with an office in Boston. In July of 1848 he assisted in founding the Boston Society of Civil Engineers, the oldest existing engineering society in this country.

Shortly thereafter he left Boston to become engineer of the Central Railroad of New Jersey, a position he retained for about three years. During this period he made plans for the extension of the road from Whitehouse to Easton, on the Delaware River.

In 1852 Laurie had a consulting office in New York. With Kirkwood and four others, he joined on October 23 of that year in issuing to civil engineers and architects in the vicinity of New York an invitation to join in organizing a professional society. In accordance with this invitation, the American Society of Civil Engineers came into being on November 5, 1852. Laurie was one of a committee of three that prepared a draft of a constitution and by-laws, and shortly thereafter he was elected president.

The following month he led the first professional discussion given before the Society. The subject was "The Relief of Broadway," and in this connection Laurie presented a plan for placing railway tracks above the level of the street.

About 1855 Laurie was engaged by New York authorities to examine bridges in various parts of the state, and three years later he was called to the Province of Nova Scotia to make an evaluation

of the existing railroad lines and to prepare plans for extensions.

After two years he returned to the States and became chief engineer of the New Haven, Hartford, and Springfield Railroad, a position he held until 1866. In 1862 he designed what is probably his greatest work—an iron lattice bridge across the Connecticut River at Warehouse Point on the line of the New York, New Haven and Hartford Railroad. The new bridge replaced a deck-truss wooden structure on stone piers, and was erected on the same piers, between the old trusses, without interrupting the traffic on the road—yet the line was single track. Theodore G. Ellis, a civil engineer writing in 1866, said: "Perhaps no similar undertaking of equal difficulty had ever been attempted. Great credit is due the engineer for having the boldness to undertake it."

The total length of the bridge was 1,524 ft, the longest span being 177 ft. The trusses consisted of built-up chords, vertical compression members, and diagonal tension bars spanning two or three panels each. Proposals for fabricating the iron work were first received from firms in this country, but owing to their being occupied with work for the government, and to the high prices of iron and labor, Laurie found that time and money could be saved by giving the contract to an English firm.

Despite the fact that the old timber trusses made the working space extremely cramped, and that the work was often interrupted by the passage of trains, erection was completed in seven months. More than 80,000 rivets were put in by hand in the field; a gang of five, says Ellis, was able to drive from 40 to 240 per day. The total cost of the iron work, in place, was 12.38 cents per pound. The bridge gave more than 40 years of service, and was finally removed about 1904.

While still busy with the bridge, Laurie began elaborate surveys for the State of Massachusetts on the Troy and Greenfield Railroad and the Hoosac Tunnel. The latter had been commenced in 1854, and was 22 years in building—although the difficulties, it is said, were not so much of an engineering nature as financial and political. It was on the Boston and Main Railroad, and was 4¾ miles in length. The first compressed-air rock drills in the United States were used there, and it was probably the first tunnel in which electricity was used for firing blasts.

Returning to New York in the fall of 1867, Laurie found that the Society had lapsed into inactivity, and he immediately began to plan for its revival. The general opinion was that the lack of permanent quarters had contributed to the lapse, by keeping the Society from serving its visiting members. Accordingly, two third-floor rooms were rented in a building at the corner of William and Cedar streets, and the Annual Meeting held there on November 6, 1867 marked the beginning of a steady growth in the number of the Society's members and in its usefulness. Laurie was accorded a resolution of thanks "for his faithful services and for his efforts to reestablish and reorganize the Society on a basis which gives promise of a successful and useful continuance."

About this time, Laurie ceased the active practice of his profession, although occasionally he was retained to report on various engineering works. He spent most of his remaining days at the Allyn House in Hartford, where he lived practically in retirement until his death on March 16, 1875. He never married.

He was buried in the Cedar Hill cemetery at Hartford. On one side of the granite monument marking his grave, there is an inscription that ends: "By his talents and industry he gained the foremost rank in his profession."

[Appreciation is due F. J. Pitcher, Assoc. M. Am. Soc. C.E., and J. L. Rippey, both of the N.Y., N.H. & H.RR. for making available Ellis's detailed account of the Warehouse Point Bridge.]

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The Society Follows the Job

A NEW Local Membership Committee, advisory to the Board of Direction in matters of applications for admission and transfer, has just been appointed at Fort Peck Dam in Montana, the second of these committees to be organized on the site of a great construction job. The first of these committees to "follow the job" was formed when the Tennessee Valley Section was authorized in the area of the far-flung TVA project.

The way in which the Fort Peck committee happened to be formed is interesting. There has been for some years a Local Membership Committee that attempted to cover the states of Idaho and Montana but which obviously has been handicapped by the great distances between centers of engineering population. When the Fort Peck Dam got under way, many engineers were employed on that project. It was somewhat of a surprise and of course a pleasure to find that quite a number of applications for admission and transfer were originating on that job. The existing Local Membership Committee was obviously at a disadvantage. Its chairman, however, rose to the occasion and suggested that a new committee be formed at Fort Peck to last for the duration of the job and to handle all applications arising out of that particular work. The new committee was appointed on February 18, 1936, having received the approval of Director Crawford, in whose District it is situated.

It will be recalled that in the December 1934 issue of CIVIL ENGINEERING, page 659, there was an article describing the work of the Local Membership Committees and indicating the dependence placed on them by the Board of Direction. The new committee will thus form a valuable link between the Society and prospective members.

Last Call for Discarded Cuts

WHEN THE PRINTER has finished with the type material in TRANSACTIONS and CIVIL ENGINEERING, the type and most of the cuts are destroyed after a reasonable interval. This is because it is extremely costly to store them all on the chance that a few may be in demand at some future time.

All the cuts from Vol. 99 of TRANSACTIONS are now due to be destroyed but, with the thought that some member might have use for some of them, they are being held until May 13. Those who mail a request for them to the Secretary, giving the figure number and the page, can have them for the cost of postage—first come, first served, except that authors of papers, of course, have first claim on their own illustrations. Permission is granted to reprint the illustrations and text matter from TRANSACTIONS on condition that the full title of the paper, name of author, page reference, and date of publication by the Society are given.

As regards cuts from CIVIL ENGINEERING, those from Volumes I, II, and III have already been destroyed. However, those from Volume IV, that is 1934, are available on request up to May 1, 1936, the date on which all cuts from that volume not previously requested will be destroyed. Those desiring cuts should make application for them to Society Headquarters. There will be no charge other than the cost of forwarding by express or parcel post. As in the case of TRANSACTIONS, requests first received will be filled first, but preference will be given to the authors of the articles in which the illustrations appear. The cuts for the covers, pages of special interest, and Society Meeting programs are also available. Cuts from Volumes V and VI, that is 1935 and 1936, will be loaned to those desiring them for some special purpose, but must be returned when that purpose has been served.

SPRING MEETING OF THE SOCIETY, April 22–25, 1936, in Hot Springs, Ark.

The Society's Committee on Research

DURING THE THREE preceding years, in keeping with the economy measures of the Society, the Committee on Research held no meetings, and functioned chiefly as an agency for collecting reports from the several special research committees and transmitting them with comments to the Board of Direction. In 1935 the committee requested instructions as to its definite powers and the extent to which it might exercise authority over research activities of the Society with the double objective of stimulating and coordinating such activities and of recommending to the Board of Direction the discharge of research committees whose assignments are completed or whose efforts are not actually adding to engineering knowledge.

GEORGE E. BEGGS
Chairman of the Committee on Research for 1935

Acting on instructions given it, the Committee on Research held a meeting in April 1935, and proceeded to consider reports from the existing special research committees assigned to its jurisdiction. The committee not only undertook to obtain progress reports from these special committees, but to determine (*a*) the justifiable expenditures required for continuation of their work; (*b*) whether the personnel of the committees should be altered; and (*c*) the probable time within which the duties of the committees might reasonably be expected to be completed. Inquiries were also made as to activities in the same or related subjects being undertaken by committees of other technical societies.

The Committee on Stresses in Railway Track—A. N. Talbot, chairman—works in cooperation with and under grants from the American Railway Engineering Association. Its present activities are chiefly concerned with studies on welded rails, effects of locomotive counterbalance upon rail stresses, rail profiles at or near rail joints, properties of the tie-plates, and superelevation of track for high-speed trains. The committee has been highly productive in the past, and is engaged upon significant studies at present.

The Committee on Cement—Thaddeus Merriman, chairman—appears to have no specific program of its own and no funds have been allotted to it by the Society in recent years. It acts as a contact committee with Committee C 1 of the American Society for Testing Materials, and with other engineering committees and societies interested in cement.

The Committee on Concrete and Reinforced Concrete Arches—Clyde T. Morris, chairman—has had a distinguished record. Its final report was published in Volume 100 of TRANSACTIONS.

The Committee on Earths and Foundations—Lazarus White, chairman—has acted not only as a coordinating and reporting committee, but also has under its own auspices conducted important experiments on soils and foundations. It is working in cooperation with specialists in several universities both in this country and abroad. An abstract of its recent activities appears in the October 7, 1935, report of the Engineering Foundation, through which it has received funds for some of its investigations. The Committee on Research endorses the continuance of this committee.

The Committee on Dams—Thaddeus Merriman, chairman—has reported little progress, confining itself hitherto largely to the subject of uplift pressure. It circulated a world-wide questionnaire on this subject in 1932. A paper by D. C. Henny of this committee has been published by the Society.

The Committee on Meterological Data—Donald M. Baker, chairman—submitted a vigorous progress report in 1931 analyzing and constructively criticizing the U. S. Weather Bureau with respect to service to the engineering profession. Largely as a result of the interest in and discussion of this report the Science Advisory Committee of the National Research Council added J. B. Lippincott, M. Am. Soc. C.E., to its subcommittee on the Weather Bureau. Mr. Lippincott, a member of the Committee on Meterological Data, is the only engineer representative on the Weather Bureau Advisory Committee. The Committee on Meterological Data has cooperated with federal agencies whose activities relate to the committee's functions. The Committee on Research endorses the continuance of this committee, but recommends the presentation of a more definite program of activities for 1936.

The Committee on Hydraulic Research—J. C. Stevens, chairman—was constituted by the Board of Direction in 1933. Its present objectives relate largely to model studies and hydraulic laboratory research. The Committee on Research is sympathetic with the aims of this committee, particularly as the coordination of its objectives with those of other related committees and of the Technical Divisions of the Society may be effected.

The Committee on Flood Protection Data—Gerard H. Matthes, chairman—was reconstituted in 1934 at the request of the Mississippi Valley Committee of the Public Works Administration to act as an advisory body in connection with a study of flood flows in the United States. The committee held a number of meetings in Washington and contributed extremely valuable advice and guidance in the prosecution of flood flow investigations and in the preparation of a Water Supply Paper of the U. S. Geological Survey on this subject. The committee has made valuable suggestions as to its future program, and in the opinion of the Committee on Research it should be continued for the present, especially as a contact agency between the Society and federal and local agencies engaged in flood studies.

The Committee on Research has been impressed with a number of factors relating to research in the field of hydraulic engineering. One of its members, Fred C. Scobey, was requested to prepare a brief upon the subject, which has been submitted to the committee. Mr. Scobey points out that the American Society of Civil Engineers should take a leading position in hydraulic study and research. He also points out the numerous divergent but often overlapping activities of various units of the Society with respect to hydraulics and related fields. He mentions among others the committees on the Freeman Fund, Dams, Meteorological Data, Flood Protection Data, Hydraulic Research, Conservation of Water, Drainage of Irrigated Lands, Duty of Water, Salvage of Sewage, Silting and Water Supply Engineering. It appears to the Committee on Research that numerous research committees, both special and related to the Technical Divisions, are concerned with hydraulics, and that a greater degree of coordination and more definitive objectives with respect to hydraulics and hydraulic research in their broader aspects are desirable.

The Committee on Research feels that the general research activities of the Society may perhaps be better coordinated, that funds for research may be better conserved, and that useful research may be even more effectively stimulated than at present if the entire research program of the Society is constructively analyzed and a more comprehensive and cohesive plan for research in civil engineering adopted.

GEORGE E. BEGGS, *Chairman*
THORNDIKE SAVILLE, *Secretary*
FRED C. SCOBEY ALBERT F. REICHMANN
CHARLES B BURDICK
Committee on Research

Publicity Department Established

A PROGRAM OF DIGNIFIED publicity for the work of the civil engineer and for the Society was initiated in January by authority of the Board of Direction. In charge of the new program, as a staff member, is W. R. E. Baxter, formerly manager of the newspaper service bureau of the McGraw-Hill Publishing Company.

The chief function of the publicity department will be to supply news releases for papers in all parts of the country. During its first week of operation, it was successful in placing in New York papers a large number of news stories about the Annual Meeting. In addition, items of interest about each of the newly elected members of the Board were released to papers in their respective localities.

with a high degree of success. Similar publicity is planned for the coming Spring Meeting at Hot Springs, Ark.

Popular digests of articles to appear in CIVIL ENGINEERING are being supplied regularly to national news services and to the science editors of a selected group of papers. Activities of Local Sections are closely followed, and write-ups of any event with "news value" are promptly distributed to the leading papers in the surrounding territory. Important achievements of individual engineers are similarly handled.

It is anticipated that the Publicity Department, by providing a central source of live, accurate information, will do much to develop a popular interest in engineering activities and a general understanding and appreciation of the work of the civil engineer.

Horatio Allen Scholarship Open

THROUGH THE COURTESY of Columbia University, New York City, the Society has at its disposal a scholarship in civil engineering covering tuition fees and dormitory accommodations, and including a $100 allowance for books and incidentals. Its total value is about $700.

The scholarship was established in honor of Horatio Allen, fifth President of the Society and a member of the class of 1823 at Columbia. It is awarded by a committee of the Society, subject to the approval of the university authorities. It may be held by the recipient for from one to three years, depending upon the class he enters at the university.

Applicants must submit credits covering at least the first two years of an engineering course at an accredited school. Those who enter at this point will thus require two years to attain the B.S. degree in engineering and an additional year for the C.E. degree. Those who have carried their studies beyond this point will also be admitted.

Applications will be received by the committee until June 1, 1936, when an appointment will be made for the academic year beginning in September. Additional information on the scholarship and detailed instruction on the proper form for applications will be furnished by the Society on request.

Regular March Business Meeting

A REGULAR business meeting of the Society, as required by the by-laws, was called to order at the Engineering Societies Building, New York, N.Y., on the evening of March 18, 1936, just preceding the meeting of the Metropolitan Section. After a few remarks, there being no business presented, the meeting was adjourned.

Society Districts and Zones Unchanged

A RECOMMENDATION of the Committee on Districts and Zones that no change be made in District boundaries, number of Directors, and boundaries of the four Zones for 1936, has been approved by the Board of Direction. This announcement is made in accordance with the requirements of the Constitution of the Society, Article VII, Section 1.

Moment Distribution Paper Reprinted

IN MAY 1930, PROCEEDINGS contained a paper entitled "Analysis of Continuous Frames by Distributing Fixed-End Moments," by Hardy Cross, M. Am. Soc. C.E., which was destined to become recognized as a milestone in the annals of technical literature. When, after two years of active discussion, the author published his closing arguments in PROCEEDINGS for May 1932, 38 engineers had recorded their appraisal of this work. The original paper of ten pages had been expanded by discussion, so that its scope in Vol. 96 of TRANSACTIONS (1932) comprised 156 pages. In this form it was awarded the Norman Medal at the Annual Meeting of the Society in New York, N. Y., on January 17, 1934.

Anticipating an active demand for reprints, the Society arranged for an unusually large stock for individual sale. This supply nevertheless became exhausted early this year. Expecting a continued demand, a new stock of reprints has been ordered at a considerable increase in cost to the Society. The selling price, however, of $1.60 per copy with a 50 per cent discount to members, has been kept the same as before.

As a service to members of Student Chapters in good standing, for classroom use, a price of 50 cents a copy in quantity orders has also been made effective. This special rate applies to purchasers of 10 copies or more if ordered through officers of the Chapters or faculty advisers. For single copies, the price to Student Chapter members is 70 cents each.

Engineers Report on Professional Development

PUBLICATION of the third annual report of the Engineers' Council for Professional Development makes available to engineers and educators a record of the activities of this body. It provides authentic information on the organization, purposes, policies, and personnel of the Council and the work of its four major committees on student selection and guidance, engineering schools, professional training, and professional recognition.

The 36-page annual report contains a list of the participating bodies and their representatives for 1935–1936; the report of C. F. Hirshfeld, chairman of E.C.P.D. for 1935; committee reports; the charter and rules of procedure of E.C.P.D.; the policies adopted by E.C.P.D. since its formation; a brief report on finances; and the committee personnel for 1935–1936.

Chief interest attaches to the four committee reports. The report of the Committee on Student Selection and Guidance—R. L. Sackett, dean of the College of Engineering, Pennsylvania State College, chairman—deals principally with tests designed to supplement methods of selecting students for engineering colleges.

Plans for putting into effect its program of accrediting engineering schools are discussed in the report of the Committee on Engineering Schools—Karl T. Compton, president, Massachusetts Institute of Technology, chairman.

An appendix to the report of the Committee on Professional Training—Robert I. Rees, assistant vice-president, American Telephone and Telegraph Company, chairman—contains an announcement of a selected bibliography of engineering subjects with samples from the civil engineering section, covering selected books on bridges, concrete, construction materials, foundations, highways, hydraulics, mechanics of materials, railroads, sewerage, and sewage disposal. Other sections of the bibliography will cover mathematics, physics, chemistry, aeronautical engineering, chemical engineering, electrical engineering, industrial engineering, mechanical engineering, metallurgical engineering, and mining engineering.

A second appendix to this report presents a preliminary survey of university extension facilities, including a general description of the scope of the courses included in the survey and a list of the educational institutions giving these courses through class room and correspondence study. A suggested operating program for the professional development of junior engineers comprises a third appendix to this report.

The report of the Committee on Professional Recognition—C. N. Lauer, president, Philadelphia Gas Works, chairman—deals with the subject of registration of engineers, and includes, as an appendix, a digest of the engineer registration laws in 35 states.

The Engineers' Council for Professional Development is a conference of engineering bodies organized to enhance the professional status of the engineer through the cooperative support of those national organizations directly representing the professional, educational, and legislative phases of an engineer's life. The participating bodies are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, the American Institute of Chemical Engineers, and the National Council of State Boards of Engineering Examiners.

Charles F. Scott, chairman of the Connecticut State Board of Registration, is chairman of E.C.P.D., and George T. Seabury, secretary of the American Society of Civil Engineers, is secretary.

Copies of the third annual report may be obtained at a cost of 25 cents by addressing the Engineers' Council for Professional Development, 29 West 39th Street, New York, N.Y.

Plan for Paid-Up Membership Withdrawn

The PLAN for paid-up Society membership that had been in effect since July 6, 1925, was discontinued as of January 1, 1936, by mutual agreement between the Society and the insurance company underwriting the plan. The discontinuance was made necessary by a 20 per cent increase in premium rates, which would have gone into effect on that date.

Because of the depression, the insurance company had twice previously been obliged to increase its rates, but up to 1936 there had been no increase in its charges to the Society.

Withdrawal of the plan naturally does not affect in any way the status of those members who have already availed themselves of it. Neither does it affect the constitutional provision whereby a Corporate Member of Affiliate may compound all future dues by a single payment of $325.

Regional Meeting Planned for Columbus, Ohio

THE CENTRAL OHIO SECTION is laying well-ordered plans for an interesting regional meeting in Columbus on May 15 and 16. Tentative plans for an excellent series of technical papers are well under way. Various committees of the Section are active and no detail is being overlooked. The business and technical sessions are to be held at the Deshler-Wallick Hotel. All Society organizations in District 9, including Student Chapters as well as Local Sections, are being invited to cooperate. A splendid meeting seems assured, and this notice may serve to advise in advance those who can plan to attend.

Ithaca Regional Meeting to Be Held May 9

A REGIONAL MEETING to be held at Ithaca, N.Y., on May 9, 1936, will be attended by members of Local Sections and Student Chapters over a wide area. The Ithaca Section will act as host to four other Sections and the Albany Engineering Society, while the Cornell Student Chapter will arrange the details for a conference of seven other Chapters. Dr. Mead, President of the Society, will be present at this first meeting of its kind in the area. The principal subject to be discussed is what the Society can do for Student Chapter members and Juniors. Limited overnight accommodations can be obtained at Willard Straight Hall. S. C. Hollister, M. Am. Soc. C.E., head of the civil engineering department at Cornell, is arranging the program.

Syracuse Section Favors Modification of Work Relief Program

AT A MEETING of the Syracuse Section of the Society, held February 11, 1936, a resolution was adopted favoring the separation of projects of the work relief program into two parts—those requiring a high degree of engineering supervision, organization, and skill, to be done under contract; and other work requiring largely unskilled labor to be performed under the direction of work relief officers. Copies of the resolution were sent to Harold L. Ickes and Harry L. Hopkins, administrators of PWA and WPA, respectively, as well as to numerous state and local officials. The text of the resolution follows:

"WHEREAS, in the development of work relief activities there is an ever-increasing tendency toward undertaking projects normally within the sphere of operations of the established construction industry; and

"WHEREAS, this encroachment of relief activities upon the sphere of the construction group is demoralizing this industry and indirectly retarding, rather than aiding, local and national recovery; and

"WHEREAS, the above tendency has been due, in part, to the short-sightedness of some public and private groups, more interested in specific projects than in the broader and more comprehensive relief problem, the rehabilitation of the construction industry and general recovery; and

"WHEREAS, unemployment in many lines of activity involving individuals of varied occupational capabilities having created the need for relief, the provision of an unprecedented amount of relief work by undertaking the construction of public works under work relief methods has resulted in placing an unreasonable burden upon this industry; and

"WHEREAS, basic changes in the selection or kind of work relief projects cannot be effected immediately without further confusion and disorganization of relief agencies; therefore be it

"*Resolved* that the Syracuse Section of the American Society of Civil Engineers goes on record as favoring the separation of projects of the work relief program into the following two classifications or parts for construction:

"1. The portion of the work requiring experienced supervision, efficient organization and a high degree of skill to be undertaken under normal construction contract arrangement.

"2. All other work requiring largely unskilled labor to be undertaken as direct work relief projects; and be it

"*Further resolved* that the attention of various public and civic agencies be called to the necessity of considering other forms of industrial relief, partly as a means of relieving the burden now carried by the construction industry alone, and partly as a means of making work relief an aid to general recovery rather than a retarding factor; and be it

"*Further resolved* that the officers of this organization be directed to forward copies of this resolution to all such persons and agencies as may be in a position to contribute to the correction of present relief policies, either as administrators or as sponsors of projects."

New Memoirs Available

TWENTY-NINE MEMOIRS—of two Past-Presidents, nineteen other Members, and eight Associate Members—have recently been made available in preprint form for distribution in limited numbers to those who request them. Other preprints, awaiting publication in the next volume of TRANSACTIONS, have been announced in past months and a number of them are still available. The additional twenty-nine are as follows:

Thomas Henry Alison	1872–1932
Charles Kyes Allen	1867–1935
Frank Karr Ashworth	1885–1935
William Wallace Atterbury	1866–1935
Almon Byron Atwater	1845–1935
Herbert Howard Bassett	1877–1935
George Butler	1864–1935
Levi Oscar Coleman	1887–1935
Henry Leo Connell	1879–1935
Frank William Flittner	1893–1935
Weston Earle Fuller	1879–1935
Allan Vinal Garratt	1857–1932
William Charles Gotshall	1870–1935
Frederick Passmore Gutelius	1864–1935
John Venable Hanna	1864–1935
Charles Jay Hogue	1870–1935
Edward Clarence Jordan	1846–1935
Irving Patterson Kane	1886–1935
Franklin Edward Leland	1889–1935
Charles Frederick Loweth	1857–1935
Edward Towler Murchison	1888–1935
William Thomas Reed	1872–1935
Louis E. Ritter	1864–1934
William White Rousseau	1873–1935
William Dwight Sample	1881–1935
Gordon Earl Sissons	1892–1935
Jonathan Parker Snow	1848–1933
Earl Eugene Sperry	1883–1935
Francis Lee Stuart	1866–1935

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

Because of an extraordinary number of important progress reports in the March issue of "Proceedings," considerable discussion has been held over one month. Two short papers of widely divergent interest are featured for the April "Proceedings" which, otherwise, will be noteworthy for its discussion of current papers. Readers should bear in mind that the May "Proceedings" is the last number before the summer recess and that discussion for this number should be submitted promptly to avoid delaying its publication until August 15. A number of papers are being closed in the next few months in order that the work of preparing them for publication in "Transactions" may be completed during June and July.

ADMINISTRATIVE CONTROL OF UNDERGROUND WATER: PHYSICAL AND LEGAL ASPECTS

The Irrigation Division's Committee on Conservation of Water has been instrumental in securing for the Society an unusual number of good technical papers on permeability of soils, water spreading, physiographical balance, precipitation absorption, and similar subjects. The forthcoming paper entitled "Administrative Control of Underground Water: Physical and Legal Aspects," written by Harold Conkling, M. Am. Soc. C.E., a member of that Committee, is a notable addition to an imposing list.

As a background for the basic arguments of his paper, Mr. Conkling begins by describing a number of localities in which the subject of underground water—its physical and legal aspects and its administrative control—is a serious problem. From this review, he proceeds to analyze the history and trend of underground water law. According to Mr. Conkling, there are four classes or "doctrines" of underground water law in the United States. These are as follows: (1) The "doctrine of unreasonable use," in which the owner of land has absolute right over the water taken from the ground without obligation to or respect for the rights of others; (2) the "doctrine of reasonable use," in which the owner of land possesses the right to the "reasonable" use of the water in the soil except that he may not export such water to the detriment of adjoining property owners; (3) the "California doctrine," in which the owner of land shares his right to the ground water with every other owner of land overlying the ground-water basin in question; and (4) the "doctrine of prior appropriation," in which the owner of land has no right to the ground water except his right in common with every other citizen of the state in which the ground water occurred. The first three are the result of judicial decision; the last is the result of legislation. In the last case, the state permits the use of water by appropriation, which must be subject to prior rights of other users whether from the surface stream or from underground sources tributary to that stream.

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SAN GABRIEL VALLEY, CALIFORNIA, LOOKING NORTH

Puente Hills in Foreground; San Gabriel Mountains in Background

© *Spence Air Photos*

MOUTH OF SAN GABRIEL CANYON

Showing Upper Part of San Gabriel Valley, Calif., in Foreground

PRE-STRESSED REINFORCED CONCRETE AND ITS POSSIBILITIES

The idea of introducing preliminary stresses in structural members to offset the effects of stresses produced by applied loads is not an essentially new one, but the possibilities for usefulness in the case of reinforced concrete design have not been so attractive until the modern development of high-strength reinforcement. In a paper for the April PROCEEDINGS entitled "Pre-Stressed Reinforced Concrete and Its Possibilities," Ivan Rosov reviews the significant literature in the field and suggests some interesting possibilities for economy in the use of this principle as applied to reinforced concrete structures. Economies in the use of the strength of the materials is not the only consideration in this question. The principle of pre-stressing permits a design in which there may be no tension across the entire section within the designed allowable load. In other words, within the permissible allowable load the structure can be made free from tension cracks, thus protecting the reinforcing steel from deterioration by exposure to air and moisture. For greatest effectiveness it is desirable that the concrete be of the strongest possible grade and that the steel be strong enough to support the applied load even after it has been pre-stressed.

The paper contains a statement of the broad theory and two numerical examples to demonstrate its application in practical use.

CLOSING DISCUSSIONS

Readers who have followed keenly the discussion of the various papers listed as "current" on the second page of each issue of PROCEEDINGS will be interested to learn of the following authors' closures which will be published in April: "The Shear-Area Method," by Horace B. Compton, Assoc. M. Am. Soc. C.E., and Clayton O. Dohrenwend, Jun. Am. Soc. C.E.; "Failure Theories of Materials Subjected to Combined Stresses," by Joseph Marin; and possibly, "Photo-Elastic Determination of Shrinkage Stresses," by Howard J. Smits; "Flood Stage Records of the River Nile," by C. S. Jarvis, M. Am. Soc. C.E.; "The Stress Function and Photo-Elasticity Applied to Dams," by H. A. Brahtz; and "Flood and Erosion Control Problems and Their Solution," by E. Courtland Eaton, M. Am. Soc. C.E.

Society Appointees

ALONZO J. HAMMOND, Past-President Am. Soc. C.E., represented the Society at the Washington Award Dinner held in Chicago on February 25.

GEORGE B. PILLSBURY, M. Am. Soc. C.E., has been appointed chairman of the Alfred Noble Prize Committee.

In and About the Society

EARLY in February each member of the Sanitary Engineering Division received a letter from the Division's executive committee describing those social and technical features of the Annual Meeting in which the sanitary engineers took part. The letter also included a detailed statement of the present status of the Division's activities and the minutes of the meeting of its executive committee. It was stated that in the future four sessions of the Division will probably be necessary each year to meet the demand for papers on sanitary engineering subjects.

* * * *

TO EXTEND as widely as possible the benefits of last fall's Student Chapter Conference at Birmingham, Ala., a detailed abstract of the stenographic record has recently been distributed to all the Student Chapters and to their faculty advisers and contact members.

Freeman Candidates Should Apply Early

ATTENTION is again called to the Freeman Traveling Scholarship in hydraulics, for which applications are now being received. The preliminary announcement was made in last month's CIVIL ENGINEERING, and additional information in the form of a mimeographed circular is available on request at Society Headquarters.

Although applications will be accepted as late as June 1, 1936, it is urged that they be submitted as long before that deadline as possible. A last-minute rush of entries will throw a heavy burden on the committee, for careful and detailed consideration must be given each candidate, and the final selection is to be made early in the summer.

News of Local Sections

CENTRAL OHIO SECTION

The new officers for the Central Ohio Section are as follows: John C. Prior, president; C. W. Allen, first vice-president; J. H. Blodgett, second vice-president; and William E. Burroughs, secretary-treasurer.

CINCINNATI SECTION

On February 6 there was a joint meeting of the Cincinnati Section of the Society and local chapters of ten other societies. Prof. Bradley Jones, of Cincinnati University, introduced the speaker of the occasion, Capt. Albert W. Stevens, of the U. S. Army. Captain Stevens gave an interesting illustrated lecture on his recent flight into the upper stratosphere in the balloon, "Explorer II." Approximately 3,000 were present. The new officers for this Section are as follows: Pusey Jones, president; Herbert H. Schroth, vice-president; and William H. Carlton, secretary.

DISTRICT OF COLUMBIA SECTION

The District of Columbia Section held its annual dinner meeting at the Washington Hotel in Washington on February 13, with 130 present. During the brief business session the officers for the past year were reelected to serve for another year, the list being as follows: R. C. Marshall, Jr., president; C. G. Paulsen, vice-president; and Medford T. Thomson, secretary-treasurer. George T. Seabury, Secretary of the Society, responded to an introduction with a few remarks. Then Dr. D. W. Mead, President of the Society, spoke on the need for high ethical standards in the profession. He was followed by H. E. Augusto Rosso, Italian Ambassador to the United States.

DULUTH SECTION

On February 17 the Duluth Section held its regular monthly meeting, with ten members and two guests present. The speaker on this occasion was Harold Matteson, a public accountant, who described and discussed the Federal Security Act.

GEORGIA SECTION

There were 44 present at a meeting of the Georgia Section held in Atlanta on March 12. It was announced that the Section's delegate to the Spring Meeting of the Society will be R. P. Black, and that the alternate will be L. F. Bellinger. W. T. Chevalier, vice-president of the McGraw-Hill Publishing Company, was the speaker of the evening. Mr. Chevalier discussed the topic of economics and finance as related to the engineer.

INDIANA SECTION

On February 19 the Indiana Section elected the following officers to serve for one year: R. L. McCormick, president; Charles Brossman, vice-president; and Fred Kellam, secretary-treasurer.

ITHACA SECTION

On February 25 a dinner meeting of the Ithaca Section was held in Willard Straight Hall on the campus of Cornell University. O. D. Von Engeln, professor of geology at the university, gave an interesting talk on the subject of "Glacial Phenomena and Engineering." There were 25 present.

KANSAS CITY SECTION

There were 44 present at a dinner meeting of the Kansas City Section held at the Newbern Hotel on February 7. After dinner and a brief business session, Frank C. Lynch spoke on the American Legion, and the Honorable Henry M. Beardsley gave a talk, inviting the engineers' attention to the Professional Men's Club. The principal speaker was S. Herbert Hare, landscape engineer and architect, who presented an illustrated lecture on the subject of state and city planning.

KANSAS STATE SECTION

On February 11 a meeting of the Kansas State Section was held at the Allis Hotel in Wichita, with 19 in attendance. Murray Wilson, consulting engineer of Salina, Kans., thanked the Section for its aid in putting his firm back on the approved PWA list. Then several members commented on the working out of the Engineers' Registration Law. During the business session the following officers for 1936 were elected: F. A. Russell, president; Ira E. Taylor, vice-president; and F. W. Epps, secretary-treasurer.

LEHIGH VALLEY SECTION

W. A. Hazard has been elected president of the Lehigh Valley Section for 1936. M. O. Fuller will continue to serve as secretary-treasurer.

METROPOLITAN SECTION

On February 25 the Junior Branch of the Metropolitan Section held a meeting in the Engineering Societies Building in New York City. The speaker on this occasion was Alfred Africano, assistant engineer for the Interborough Rapid Transit Company, who described the design and testing of motors for stratosphere rockets. Talking motion pictures on the manufacture and use of special steels were shown at a meeting of the Junior Branch held on March 10. The second half of each of these meetings was given over to speech making by juniors who are preparing for the annual public speaking contest sponsored by the Metropolitan Section.

NORTHWESTERN SECTION

A meeting of the Northwestern Section was held at the University of Minnesota on February 14. The feature of the occasion was a talk by John I. Parcel, of the consulting engineering firm of Sverdrup and Parcel of St. Louis. Mr. Parcel spoke on the experiences of his firm in connection with the promotion, design, and construction of several bridges, built over the Mississippi and Missouri rivers under the federal public works program. There were 25 members and guests present.

PHILADELPHIA SECTION

On February 22 the Philadelphia Section celebrated Washington's Birthday by holding its annual social meeting, which attracted an attendance of 190. The program was in charge of Lyle

Jenne, who utilized all the entertainment traditions of the occasion to make the gathering colorful. After dinner a quartet from the Engineers' Glee Club presented a musical program, which was followed by a skit and magician's performance. Group singing was also enjoyed, as was a demonstration of the "Photona," an electric organ-like instrument, shown through the courtesy of the W. C. A. U. Broadcasting Company and the Franklin Institute. The evening concluded with a dance, which lasted until the small hours. Secretary Seabury was guest of honor for these festivities.

PORTLAND (ORE.) SECTION

A meeting of the Portland (Ore.) Section was called to order at the University Club on February 21. There were 58 present. After an announcement of the new committees had been made, a symposium on the subject, "Problems Relating to the Control of the Ruckle Slide near Bonneville, Ore.," was presented. The speakers on this program were as follows: Samuel Murray, chief engineer of the Union Pacific Railroad, who told of his early experiences in combating the slide; C. I. Grimm, chief engineer of the Bonneville Dam project, who related the experiences of the army engineers in the same connection; Edwin T. Hodge, consulting geologist on the project, who described the geology of the slide; and J. P. Newell, consulting engineer of Portland, who recalled his observations at Ruckle Slide during the flood of 1894.

SACRAMENTO SECTION

The Sacramento Section continued its practice of holding weekly luncheon meetings during January, the attendance on these occasions ranging from 20 to 50. The meetings held on January 7 and 14 were devoted to a discussion of business matters. On January 21 the meeting was addressed by Charles R. Wilson, of the American Lumber and Treating Company, who spoke on the subject of termite control. At the meeting held on January 28 the speaker was George C. Pollock, a contractor of Sacramento, whose topic was "The Relationship Between the Contractor and Engineer." The annual dinner dance and installation of officers took place on January 17 at the Hotel Senator, with 130 present. Following dinner Clarence H. Kromer, the retiring president, presented a paper on "Outstanding Engineering Accomplishments of the Past Year." The new officers for the Section are as follows: Walter E. Stoddard, president; Edward E. Welsh, first vice-president; Herbert H. Hodgeson, second vice-president; and Frank D. Talbot, secretary.

SAN FRANCISCO SECTION

There were 125 present at a meeting of the San Francisco Section held at the Engineers' Club on February 18. During the business session Fred C. Scobey, senior irrigation engineer, U. S. Department of Agriculture, discussed the formation of a proposed hydraulic division. The speaker of the occasion was A. J. Cleary, city administrator of San Francisco, who talked on the organization and administration of the San Francisco municipal government, making special reference to functions relating to engineering.

SEATTLE SECTION

On January 20 the Seattle Section held its annual election of officers, the president for 1936 being Ray M. Murray and the secretary, Fred H. Rhodes, Jr.

SYRACUSE SECTION

A joint meeting of the Syracuse Section of the Society and the Technology Club of Syracuse was held in the Onondaga Hotel on February 24. The speaker and guest of honor was K. C. Reynolds, assistant professor of hydraulics at Massachusetts Institute of Technology, who gave an illustrated lecture on the "Cape Cod Canal Hydraulic Researches." Previous to the meeting, Professor Reynolds was entertained at dinner by members of the Section and local alumni of Massachusetts Institute of Technology.

TACOMA SECTION

There were 26 present at a dinner meeting of the Tacoma Section held at the Tacoma Hotel on February 10. The guest speaker was J. Kenneth Pierce, of the College of Forestry of the University of Washington. Professor Pierce gave a highly instructive account of his engineering experiences in India and the Andaman Islands.

TEXAS SECTION

The Texas Section, which for several years has been sponsoring the enactment of a state registration law for engineers, is laying plans for a renewed campaign in the coming months. The work is under the direction of a committee on legislation composed of A. J. McKenzie, chairman, and Grayson Gill, J. M. Howe, Don Lee, C. M. Davis, T. B. Warden, T. E. Huffman, and C. M. Blucher.

UTAH SECTION

Election of officers for 1936 took place at a meeting of the Utah Section held in Salt Lake City on January 17. The list of these officers is as follows: K. C. Wright, president; O. C. Lockhart, first vice-president; R. A. Hart, second vice-president; and F. H. Richardson, secretary-treasurer. Upon the conclusion of the routine business of the Section, T. C. Adams, associate professor of civil engineering at the University of Utah, gave an interesting description of a recent trip to the Grand Coulee and Bonneville dams and the bridges on the Pacific highway along the Oregon coast, and the San Francisco Bay Bridge.

Student Chapter Notes

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

On February 11, W. S. Mahlie, chief chemist for the city of Fort Worth, Tex., addressed a meeting of the Agricultural and Mechanical College of Texas Student Chapter. Mr. Mahlie gave an interesting account of the many problems confronting the sanitary engineers of Fort Worth. Illustrating his talk with lantern slides, he showed how the city has successfully met the problem caused by the additional disposal of waste from the great meat packing plants of Fort Worth.

RHODE ISLAND STATE COLLEGE

A meeting of the Rhode Island State College Student Chapter was held on February 20. The speaker on this occasion was Col. Henry W. Durham, of Sandwich, Mass. Colonel Durham gave an interesting talk on his varied experiences in civil and military work on such projects as the Panama and Cape Cod canals, and on paving operations in Nicaragua and New York City. The entire senior class and two faculty members were present

TUFTS COLLEGE

There were 26 present at a meeting of the Tufts College Student Chapter held on Feburary 17. The guest of honor was Walter E. Jessup, Field Secretary of the Society, who gave a talk on the history and growth of the Society and described the work being done by the other Student Chapters that he has visited. The other speaker was Francis H. Kingsbury, contact member for the Section, who discussed the dangers of attempting to cover too many engineering fields in one's choice of work. Prior to the meeting a luncheon was given for Mr. Jessup, Student Chapter officers, and others by Prof. Harry P. Burden. On January 25 several members of the Chapter attended the annual meeting of the Northeastern Section.

UNIVERSITY OF TEXAS

A special meeting of the University of Texas Student Chapter was called to order on February 10 in honor of Arthur N. Talbot, Past-President and Honorary Member, who was passing through Austin. Professor Talbot gave a short talk on the improvements that have taken place in engineering education. On February 14 the Chapter was well represented at a meeting of the Austin Technical Club. The speaker on this occasion was D. B. Steinman, president of the National Society of Professional Engineers and consulting engineer of New York City, who discussed the subject of "The Social Status of Engineers."

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for May

AMONG the articles scheduled for publication in the May issue is one by M. N. Lipp, Assoc. M. Am. Soc. C.E., city engineer of Miami Beach, Fla. In an effort to obtain first-hand information on the many types of groins and bulkheads used for the protection of Florida shores and beaches, he has recently completed a detailed study of existing works for a distance of 64 miles up the coast to Palm Beach. In each case he noted the degree of deterioration and the efficiency of the steel, concrete, or wood structure, as the case might be. This investigation confirmed Mr. Lipp's preference for steel sheet-pile bulkheads and groins, the latter of adequate length, properly spaced, and braced with pretreated timber.

In another article the methods used in planning, laying out, and developing the 75,000-acre Borough of Queens, New York, are described by Charles U. Powell, M. Am. Soc. C.E., engineer in charge of the Borough's topographical bureau. The officials of Queens, which is a part of New York City, have power under the law to lay out undeveloped private lands and to force the owners to conform to their designs. Roads connecting villages were widened and straightened and grades were reduced. Since 1921 a system of parkways and arterial highways capable of carrying high-speed traffic long distances without grade intersections has been constructed, at a cost of approximately $25,000,000. The success of the planning and construction work must be attributed in large part to the foresight and vision of its sponsors.

Many motorists remember the old "floating-fill" roads which used to meander across swamps, supported on logs floating in the unstable, water-saturated soil. Modern high-speed traffic has been a major factor in the abandonment of such surfaces in favor of wide, straight highways extending directly across marshy areas. Where extreme conditions prevail, as described by J. M. Jeffries, technical representative of the Atlas Powder Company, the new road fill is sometimes sunk to solid bottom in a predetermined path by blasting out the underlying semi-liquid material. In the so-called "wedge" method, explosives under the margins of the road are fired a fraction of a second before those under the fill, thus providing a way of escape for the unstable material and permitting the fill to settle vertically to the bottom of the swamp.

To augment the flow of the Owens River Aqueduct, Los Angeles is preparing to divert the larger part of the Mono Basin drainage. An 11-mile tunnel leading from Mono Basin to the Owens River watershed is now under construction, and unusual progress is reported. Other important features of the Mono Basin project are two storage reservoirs and several miles of reinforced concrete conduit. The project will be described in the May issue by H. A. Van Norman, M. Am. Soc. C.E., chief engineer and general manager of the Los Angeles Bureau of Water Works and Supply.

The Path of Empire

WITHIN the memory of some still alive, covered wagons lumbered into an unknown West, their wheel tracks in the prairie dust charting a nineteenth century "path of empire." Years passed, and with them, the frontier. The path was no longer a physical trail leading west, or north, or south; but it was none the less still real. Its modern aspect is the closer knitting together of hundreds of cities from coast to coast.

The current page of special interest combines these aspects. Above the pioneer caravan, taken from a painting by Frank Hoffman, has been depicted a modern stream-lined train. The addition does not seem to make necessary any departure from Hoffman's original title—"The Path of Empire."

Hoffman's painting hangs in the board room of the Chicago, Burlington and Quincy Railroad, in Chicago. Elsewhere in this issue Ralph Budd, M. Am. Soc. C.E., president of that road, tells the story of new developments in rail transportation.

More About Society Pins

"SOME YEARS AGO," writes Theodore Belzner, Affiliate Am. Soc. C.E., of Brooklyn, N.Y., "while commuting for the summer months between New York City and Ridgefield Park, N.J., I noticed one day that my Society pin was missing from my vest. I made a number of inquiries for it without result. Then I applied at the lost and found office of the railroad company, giving the name of the Society and otherwise describing the article. The clerk informed me that such a pin had been found, and after signing a receipt I received an envelope containing a hard object and started home on the ferry in an elated mood. Upon opening the envelope I found to my amazement a blue-enameled Society pin, whereas mine had been maroon—the color formerly used for Affiliates. I had neglected to state the color of the pin I had lost! The Secretary of the Society gave me the address of the foundling's owner, and I returned the pin to the latter in due course.

"When the Christmas season approached, I suggested to my wife that a new pin would make an excellent Christmas gift, to which she assented immediately. On Christmas morning I received a large package containing a great deal of wrapping and (eventually) a small box. I opened the box and discovered my pin that had been lost! My wife had found it and had taken this means to return it. However it was as good as a gift and—'the pin came back.'"

Afghan Students Seek Engineering Literature

CIVIL ENGINEERING is in receipt of a communication from the librarian of the school of civil engineering at Cornell University, asking that the following item be inserted in this publication:

"There is a very fine group of students from Afghanistan, graduating from the School of Civil Engineering of Cornell University this year, who are going back to their own country to work under the heavy handicap of not having an engineering library of any kind in Afghanistan.

"There are probably many engineers in the United States who have files of old engineering periodicals, books no longer used, old editions, etc., who would be glad to donate them for such a purpose. A list of such books and periodicals sent to this library would be used for making up a suitable collection.

"The Afghan Minister in London will see to the transportation, and to the care of the books as the nucleus of an engineering library, by the Minister of Education at Kabul."

The request for lists of available books and periodicals from prospective donors, instead of the books and periodicals themselves, is made in order to avoid duplication. Those who are willing to contribute material for the Afghanistan engineering library should send their lists to M. H. Walbridge, Librarian, School of Civil Engineering, Cornell University, Ithaca, N.Y., who will communicate with them direct regarding details of shipment.

Booklet Issued on Continuity in Building Frames

PUBLICATION of a 60-page booklet giving practical methods for analyzing concrete building frames subjected to vertical load, wind pressure, and earthquake forces, is announced by the Portland Cement Association. Underlying assumptions, derivations, and discussions are all presented, and illustrative problems are included for the use of structural designers. The booklet is available without charge by request to the Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.

Brookings Institution Completes Economic Study

AFTER THREE YEARS of studying the American economic system, the economists of Brookings Institution, Washington, have summed up their findings in a report published recently, entitled "Income and Economic Progress." This includes a summary of three other volumes published during the past three years in which the workings, good and bad, of that system have been surveyed.

If capitalism is to succeed fully, says the report, it must pass on to the man in the street the benefits made possible by its engineers and other technicians. Lower prices resulting from efficiency rather than wage cutting mean greater consumption. Greater consumption means greater volume for the industrialist and a higher level of living for the consumer. The primary responsibility for passing on the benefits of technological progress and rising production rests with industrial managers. But the Brookings study shows that a responsibility of almost equal magnitude must be shouldered by engineers and other technicians. This responsibility arises out of the arresting fact demonstrated by the book that even if America's existing industrial plant were operated to full capacity and efficiency, it could not supply to every American an adequate standard of living. The expansion of plants and the refinement of processes, as made possible by expansion of consumption, is the social obligation of engineers.

The report opens with a survey of the productive capacity of America's industrial mechanism. "The economic system works very imperfectly at best. . . . As a general average over the 14-year period from 1922 through 1935, the productive mechanism by means of which our wants are supplied may be said to have run at little more than two-thirds efficiency." At the peak of the 1928–1929 boom the mechanism did not operate at more than 80 per cent capacity.

Because the people's standard of living can rise only as fast as they can obtain additional commodities and services, and because their income depends on what they produce, this failure to operate at capacity has meant a huge loss to America, the Brookings study explains. Technical deficiencies did not retard the industrial machinery. There has been no shortage of raw materials, fuel, transportation, labor, credit, or merchandizing facilities. Lastly, there has been no shortage in the actual demand for goods. America has not produced more than she can consume, and the myth of over-production is thus dispelled.

"There were (in 1929) nearly 6 million families with incomes less than $1,000 . . . and over 19 million, or 71 per cent of the total, with incomes less than $2,500," the report asserts. "To raise the income [of these families] . . . to a $2,500 level, with no changes in the incomes of the families receiving more than that amount, would have required an increase in national production of more than 16 billion dollars. . . . To give all the families of the nation a 'reasonable standard' of living, such as is set forth in studies made by the Bureau of Home Economics of the U. S. Department of Agriculture, would have necessitated an increase in production over 1929 levels of approximately 75 per cent."

A 75 per cent increase in production is no mean aim. But first there will have to be reforms in the strictly economic, as contrasted with the mechanical, processes in America. For obviously, the millions of families who in 1929 could have increased their consumption of goods had no means for obtaining those goods. There was a demand for larger production, but it was a helpless demand. This inability to secure the wherewithal for a "reasonable standard" of living, "Income and Economic Progress" concludes, results from the accumulation of a disproportionate share of national earnings as idle savings. Since the amount of money saved out of the national income depends largely on the share of the income that goes into the hands of the relatively wealthy, the problem is one of income, or rather, the purchasing power of those less well-to-do groups who will spend their increased share in the absorption of increased production.

The Brookings study examines and rejects most of the economic panaceas which have been advanced for this condition. "Sharing" our wealth will not work because the wealth, which is in buildings, livestock, chattels, land, and other cumbersome forms, is not divisible. Shortening the work week or otherwise limiting production means to freeze the national economy on a plane where 19 million families have less than an adequate standard of living. Taxing large incomes to finance government employment projects usually means diverting wealth into non-productive types of public works. The trade union thesis of increasing money wages for union workers produces friction and deadlocks and eventually means higher costs to the consumer, which offset in part the wage increase for those who secured it and leave everyone else much worse off.

In contrast to these suggestions, the Brookings study proposes the maintenance of wages and the reduction of the cost of goods by every cent which increased technical efficiency makes possible. Thus, reduced costs will make each dollar go farther, will put more things within the reach of consumers, and therefore will raise both production and the country's standard of living. "Income and Economic Progress" sets forth the suggestion as follows:

"Under a system which is operated with a view to private profits, each business manager strives in every possible way to reduce his costs of production. . . ." When this is accomplished, "he is in a position to increase his profits in one or another of two ways. He may continue to sell at the same price as before, enjoying the advantage of a wider margin between cost and selling price; or he may expand the volume of his business by means of price concessions. Since the increase in efficiency which is responsible for the reduction in costs commonly involves an expansion of productive capacity, and since the maximum economies can be obtained when operating at full capacity, the wise alternative obviously is to expand sales by offering the products at a lower price.

"In short, increased efficiency makes possible lower prices, while the profit incentive insures the actual reduction of prices. The greatest profit to the business enterpriser is thus derived through giving to the masses the most for their money.

"The gains resulting from increasing technological and operating efficiency are passed on to consumers through the medium of price reductions. . . . The expanding demand required to take the increasing quantities of goods off the markets would be automatically created by the reduction in prices. Note that the theory of progress under capitalism thus outlined definitely implies the maintenance of money wages. . . ."

Dr. Harold G. Moulton is the author of the Brookings Institution report. Eugene S. Duffield, of the *Wall Street Journal* Washington staff, prepared the summary from which the foregoing article was abstracted.

Engineers' Services on Boulder Dam Commemorated

SEVERAL MEMBERS of the Society are on the list of those to whom Six Companies, Inc., contractors on the Boulder Dam project, recently presented medallions. Two classes of awards were made—those to government engineers to commemorate this important project, and those to employees of the Six Companies, Inc., in recognition of their services. In all, 26 gold and 54 silver medals were struck, after which the die was destroyed. Each medal was accompanied by a personal letter from the president of the company.

The list of those to whom gold medallions were presented includes the late Elwood Mead, R. F. Walter, S. O. Harper, John L. Savage, Walker R. Young, Philip Hart, and Francis T. Crowe, Members Am. Soc. C.E.; and Stephen D. Bechtel, Assoc. M. Am. Soc. C.E. Silver medallions were presented to A. H. Ayers and A. R. Olds, Members Am. Soc. C.E.; J. P Yates, George Havas, Arthur Donaldson, and Herbert Murner, Associate Members Am. Soc. C.E.; and Edgar F. Kaiser, Jun. Am. Soc. C.E.

SPRING MEETING OF THE SOCIETY, April 22–25, 1936, in Hot Springs, Ark.

Wise and Otherwise

IN SELECTING a topic for this issue, Professor Abercrombie obtained the consent of Professor Rugwell, who conducts a similar column in *The News*, official organ of the Philadelphia Section, to reprint with minor changes a problem which appeared some time ago in that publication. The problem involves the shortest surface distance between a point one foot above the floor on a vertical line bisecting the end wall of a room, to a point on the opposite end wall on a similar vertical line, one foot below the ceiling. The room is 30 ft long, 12 ft wide, and 12 ft high. Professor Abercrombie states that the shortest surface distance can be computed by simple geometrical methods, and adds that it is *not* 42 ft.

The problem for March involved the solution of the following expression:

X U R) I E A M S (R X
I T D I

D R E S
D R E S

It will be noticed that R multiplied by R gives a number ending in I. Then R may be either 2, 3, 4, 7, 8, or 9, making I either 1, 4, 6, or 9. Trying each of these values for I in turn, it will be found that other conditions of the problem require $I = 4$, $R = 8$. Then $X = 5$, $S =$ zero, and so forth. The key is as follows:

A D M I X T U R E S
1 2 3 4 5 6 7 8 9 0

No more literal problems are planned for the immediate future. Suggestions for problems of other types may be addressed to the editor. Solutions in each case should preferably be enclosed in a separate envelope. The problems seem to have aroused considerable interest. Quite a number have been submitted by readers. Consequently a rigid basis of selection will be necessary.

Midwest Power Engineering Conference

THE MIDWEST Power Engineering Conference will hold its annual meeting in the New International Amphitheater in Chicago, April 20–23, 1936, inclusive. Twelve technical sessions are scheduled, at least two of which—one on power economics and one on power plant buildings and dams—will be of special interest to civil engineers. Other sessions will be devoted to such subjects as power economics, power-plant technics, fuel utilization, and refrigeration.

An important feature of the conference is to be a large exhibit of power equipment by various manufacturers. Educational displays, including models of machines from the time of James Watt to the present, will also be on view.

Affiliate members of the conference include 14 local engineering societies in midwestern cities, and manufacturers' associations in Illinois and contiguous states.

New Foundation Will Study Air Contamination

AIR HYGIENE Foundation of America, Inc., has been formed by a large group representing various industries, with headquarters at Thackeray Avenue and O'Hara Street, Pittsburgh, Pa. The purposes of this organization are to conduct investigations of and to stimulate research on problems in the field of air hygiene and to gather and disseminate factual information relating thereto. It will also cooperate with and assist other agencies active in this field and will collaborate in the coordination of such research efforts. A comprehensive investigation has been begun at the Mellon Institute of Industrial Research, Pittsburgh, under the support of the Air Hygiene Foundation of America, in which the hygienic, technologic, and economic aspects of air contamination, especially by dust in the industries, will be studied.

New Standards of Interest to Engineers

A PROPOSED simplified practice recommendation for sizes of coarse aggregates, crushed stone, gravel, and slag has been mailed to producers, distributors, users, and others interested for their consideration and approval, according to an announcement of the Division of Simplified Practice of the National Bureau of Standards.

The recommendation consists of two tables designated as Group A and Group B sizes of coarse aggregates. Each table gives the size number and nominal size of square openings of sieves, the approximate size of round openings, and the percentage by weight of aggregate finer than each sieve for primary, combined, and modified sizes. Two tables showing typical uses for group A and Group B sizes are included.

Copies of the proposed recommendation, which includes the history and development of the proposal, can be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D.C.

Proposed revisions in the simplified practice recommendations for metal lath (R3-28) and classification of iron and steel scrap (R58-28) have also been prepared for consideration and approval, and copies of them are available at the same address.

How Steel Wire Is Made

IN RECENT YEARS the steel industry has made about as many tons of wire in various sizes as it has structural shapes. The total length of wire drawn last year was nearly 56,000,000 miles, and in 1929 double this quantity was produced.

All steel wire is made from wire rods which usually are round in shape and wound in coils. Wire drawing consists of drawing or pulling a rod through holes in a series of dies, each hole being somewhat smaller than the rod passing through it. In consequence, after each trip through a die, the rod or wire loses some of its thickness, but lengthens in proportion.

Hard cast iron, alloy steel, and genuine diamonds are the most frequently used materials for dies, but a recently developed material called cemented carbide, which is nearly as hard as the diamond, is also successfully used. The die hole is wider at the entering end than at the exit end, and is carefully polished. As the die is used the hole enlarges little by little, so that eventually it becomes too large to reduce the wire to the desired size. It is then reamed out so as to be available for drawing the next larger size of wire.

Some preparation is necessary before rods as they come from the rod mills can be drawn. Spring steel must be heat treated, and all rods, whether heat treated or not, must be thoroughly cleaned in acid and then rinsed in water before drawing.

Next comes what seems to be a thoroughly contradictory step. The rods are made to rust in order to keep them clean and to lubricate them while they pass through the die! Finally they are dipped in a solution of lime and dried in ovens.

After the coils of rods are ready for drawing they are placed on a reel, and one end of the rod is hammered to a point and threaded through the die hole. The first few feet of the rod are pulled through the die and attached to a large motor-driven drum called the "block."

There are two ways to draw wire. One method is to draw it through one die at a time, then rethread it and draw it through another and smaller die. There is also a continuous process in which the wire passes through a series of as many as a dozen dies. In the continuous process each die in the series is followed by a drum speeded up to take up the slack caused by the lengthening of the wire due to the action of the preceding die.

This method is highly successful in the drawing of very fine wires. Some idea of the pick-up in the speed of the wire as it travels through the successive dies may be gained from the fact that although the wire moves at only approximately 150 ft per min through the first die, as it leaves the final die it may be traveling as fast as 20 miles an hour.

The squeezing and stretching which wire undergoes during manufacture greatly changes its characteristics. It gets harder, stronger, and stiffer after each trip through a die until finally it may become too brittle for most uses. These effects are corrected by heat treatment. About 160,000 different uses for wire are recorded.

Weekly News Letters Explain Akron's Engineering Problems

FOR MORE than a year, the Director of Public Service of the City of Akron, Ohio, has been releasing weekly news letters describing the work of his department. The first letter "consisted of educational material on the cost of various public utility

services in Akron," according to the *Engineering Experiment Station News* of Ohio State University. "The letters since then have touched on almost everything the city does for its inhabitants."

The director, E. A. Kemmler, M. Am. Soc. C.E., does not write all the letters; rather, "he has encouraged his division heads. . .to contribute information on the work they are doing, incidentally benefiting the officials as well as the public by giving them recognition and opportunity for expression." The news release is believed to have contributed to the building up of more pleasant relations between the public and the department of public works.

Brief Notes from Here and There

OF THE 500 CANDIDATES taking the January 1936 written examination for licensing as professional engineers in New York State, 89 were conditioned, 25 failed, and 386 passed, according to an announcement by D. B. Steinman, M. Am. Soc. C.E., a member of the board of examiners. He also reports that at the February meeting of the board, 169 applications were considered. Of these, 12 were held for interview, 53 were scheduled for written examination, 47 were rejected, and 57 were approved for license.

* * * *

BY WAY of celebrating his eightieth birthday (December 23, 1935) Frederick N. Willson, M. Am. Soc. C.E., professor emeritus of graphics and engineering drawing at Princeton University, walked the entire length of the Golden Gate Bridge catwalk, and finished his stroll with a climb down the 75-ft ladder on the outside of one of the towers. Mr. Willson's first river crossing via catwalk took place 58 years ago, when the Brooklyn Bridge was under construction, and in 1929 he traversed the George Washington Bridge by the same route. It is recalled that at least three other members of the Society—Robert Ridgway, Thurston C. Culyer, and Walter F. Whittemore—have crossed the catwalks of both these New York spans, but no one, so far as we know, has as yet tied the Willson record.

* * * *

FOOL'S GOLD—iron pyrites—may be the cause of serious foundation troubles, according to the Ohio State University *Engineering Experiment Station News*. In one case, it is said, although foundations were resting on undisturbed shale, columns were found to have been squeezed "until they were trying to attain a modified S-shape." It was found that pyrites in the shale, inert for thousands of years, had been changed by contact with the air into compounds occupying 13 times as much space. It has been suggested that such difficulties can be prevented by covering the shale, as soon as it is exposed, with a mastic seal coat that will exclude oxygen, or keeping it saturated with water to carry away the expanding compounds as they are formed.

NEWS OF ENGINEERS

From Correspondence and Society Files

JAMES S. BURCH was recently appointed engineer of statistics and planning for the North Carolina State Highway and Public Works Commission, with headquarters in Raleigh, N.C. He was formerly executive secretary-treasurer for the Corrugated Pipe Code Authority of Chicago, Ill.

H. L. NEWHALL, has accepted a position with the Resettlement Administration in Washington, D.C. Mr. Newhall was for many years chief engineer of the Akron (Ohio) water works.

GLENN D. HOLMES has resigned as chief engineer of the Syracuse Intercepting Sewer Board to become director and chief engineer of the Onondaga County Sanitary Sewer and Public Works Commission on the construction of a sewerage system and treatment works.

JOHN F. LABOON has resigned from the firm of Chester, Laboon, Campbell, Davis and Bankson of Pittsburgh, Pa., to accept a position as director of the Department of Highways, Bridges, and Tunnels of Allegheny County, Pennsylvania.

FREDERICK H. PAULSON, structural engineer for F. P. Sheldon and Son of Providence, R.I., during a year's leave of absence, has been engaged on a PWA project at Howard, R.I., with the architect, O. Di Saia.

ROBERT A. SUTHERLAND has taken a position with the Central Nebraska Public Power and Irrigation District, with headquarters at Hastings, Nebr.

FRANK J. KISH was recently transferred from the Construction Plant Division of the Tennessee Valley Authority at Knoxville, Tenn., to the Chickamauga Dam project near Chattanooga, where he is chief of party on construction.

J. F. W. GEBHARDT is now regional engineer inspector for the Finance and Control Division of the Resettlement Administration, with headquarters at Champaign, Ill. He was previously supervising engineer for the U. S. Coast and Geodetic Survey at Princeton, N.J.

RALPH W. HUTCHINSON, former associate construction engineer on the San Francisco–Oakland Bay Bridge, has moved from San Francisco to Glendale, Calif., where he is associate engineer in the Bridge Department of the California State Division of Highways.

FRANK B. CAMPBELL, who was formerly employed on the construction of the Sutherland Dam of the Platte Valley Public Power and Irrigation District in Nebraska, is now associate soil conservationist with the U. S. Soil Conservation Service at Statesville, N.C.

H. SIDWELL SMITH has resigned from the Iowa State Planning Board to take a position with Young and Stanley, Inc., of Muscatine, Iowa.

FRANKLIN ROGERS, formerly a structural engineer for the National Park Service in San Francisco, Calif., is now in a similar capacity with the Bureau of Architecture of the Southern Pacific Company. His headquarters are in the same city.

THERON N. MIZE, formerly with the U. S. Forest Service at Harrisonburg, Va., is now superintendent of the Water and Light Commission of Commerce, Ga.

BENJAMIN L. GRIMES, JR., has resigned as sanitary engineer of the El Paso–Hudspeth-Culberson County (Texas) Health Unit, to accept a similar position for the territory of Alaska, with headquarters at Juneau, Alaska.

JAMES M. MITCHELHILL is now a junior engineer in the Chicago office of the Chicago, Milwaukee, St. Paul and Pacific Railroad.

GEORGE E. HYDE, formerly with the Department of Parks of the Borough of Queens, is now employed in the U. S. Waterways Experiment Station at Vicksburg, Miss.

JOHN G. MARR is now associate engineer and city planner in the Housing Division of the Public Works Administration, with headquarters in Washington, D.C.

MONS H. BENSON recently left his position in the design section of the Canals Division of the U. S. Bureau of Reclamation to become designing engineer for the Central Nebraska Public Power and Irrigation District, located at Hastings, Nebr.

LEE G. WARREN, who was recently appointed construction engineer in charge of building Chickamauga Dam for the Tennessee Valley Authority, has been promoted to the position of project engineer on this work. He was formerly construction manager for the Frederick Snare Corporation on the construction of Tygart Dam at Grafton, W.Va.

JOHN F. STEVENS was unanimously elected to honorary membership in the Engineers' Club of New York by the board of management of the club at a meeting held on February 13.

MERRILL BERNARD is now hydraulic engineer of watershed and hydrologic studies for the U. S. Soil Conservation Service. His headquarters are in Washington, D.C. Mr. Bernard was previously a member of the consulting engineering firm of Gregory and Bernard, of New Orleans, La.

F. M. REXACH, formerly with the Department of Commerce, U. S. Geodetic Survey, is assistant resident engineer inspector for the Public Works Administration on the construction of the Midtown Hudson Tunnel.

DECEASED

OTTO RAE ELWELL (M. '30) bridge engineer for the Washington State Highway Department, died at Olympia, Wash., on November 13, 1935, at the age of 45. He was born in Aberdeen, Scotland. From 1908 until 1915 he was employed in a surveying capacity by the Union Pacific and the Canadian Northern railways, as well as by other lines. In 1915 Mr. Elwell became an assistant engineer in the Ohio State Highway Department, and from 1917 to 1919 he served with the U. S. Engineers in France. From January 1922 until his death he was in the Washington State Highway Department, being in charge of the bridge department from 1927 on.

JOHN DE BARTH WALBACH GARDINER (Assoc. M. '15) president of the construction engineering firm bearing his name, died at his home in New York City on February 12, 1936. He was 56. Mr. Gardiner graduated from the U. S. Military Academy at West Point in 1905 and remained in the army until 1910, part of the time as an instructor at the academy. In that year he accepted an engineering position with the Minwax Company of New York, specializing in the waterproofing of structures. Later he organized the firm of which he became president.

ORA L. HEMPHILL (Assoc. M. '27) construction engineer for the Arkansas State Highway Commission, died in Little Rock, Ark., on February 29, 1936. Mr. Hemphill was born in Norton, Kans., on October 5, 1888, and graduated from Oklahoma Agricultural and Mechanical College in 1909. His early experience included surveying and drafting work in Oklahoma and Arkansas. During the war he was first lieutenant in the Corps of Engineers, later being promoted to the rank of captain. In 1922 he joined the staff of the Arkansas State Highway Department, remaining there until his death, except for three years as vice-president of the Harvey Brown Construction Company.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

FRANCIS ALBERT LANDRIEU (Jun. '26) was killed in an automobile accident in Minnesota on July 4, 1935. He was born in New Orleans, La., on April 10, 1904. In 1925, upon his graduation from Tulane University, he joined the engineering staff of the Board of Commissioners of the Port of New Orleans. From 1929 until 1932 Mr. Landrieu was a design draftsman in the Public Works Department at Hampton Roads, Va. In the latter year he returned to New Orleans to rejoin the staff of the Board of Commissioners in the capacity of structural engineer.

FRANK AMENDE MUTH (M. '26) superintendent of the 17th Lighthouse District, died in Portland, Ore., on January 31, 1936. He was born in Kirksville, Ky., on January 27, 1887, and graduated from the University of Missouri in 1910. Mr. Muth was employed in the federal lighthouse service for 24 years. From 1911 until 1935 he was lighthouse engineer and assistant superintendent of the 8th Lighthouse District at New Orleans. In 1935 he was promoted to the position of superintendent of the 17th Lighthouse District.

ANDREW JACKSON POST (M. '12) president of the steel contracting firm of Post and McCord, Inc., of New York City, died there on February 25, 1936, at the age of 64. Mr. Post had a long career in the building industry. He was born in Jersey City, N.J., on November 17, 1871. In 1892, upon his graduation from the Stevens Institute of Technology, he joined the firm of Post and McCord, which had been founded by his father. Since 1912 he had been president. During that time he directed the steel construction on such notable structures as the Chrysler Building, the Metropolitan Tower, and the Empire State Building, in New York City. He was a member of the executive committee of the New York Building Congress and of the board of directors of the American Institute of Steel Construction.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From February 10 to March 9, 1936, Inclusive

ADDITIONS TO MEMBERSHIP

ALLEN, ROBERT BENTON (Jun. '36), 89 Tod Lane, Youngstown, Ohio.

ALLIN, RALPH WALTER (Assoc. M. '36), With Hydrographic Div., Pasadena Water Dept. (Res., 1660 North Garfield Ave.), Pasadena, Calif.

ASPLAND, GEORGE HENRY (Assoc. M. '36), Res. Engr., PWA, New York (Res., 1059 Bergen St., Brooklyn), N.Y.

BERRY, DAVID MAURICE (Jun. '36), Senior Eng. Field Aid, State Div. of Highways, San Francisco–Oakland Bay Bridge, San Francisco (Res., 2322 Shattuck Ave., Berkeley), Calif.

BROECKER, CLETUS ANDREW (Assoc. M. '36), Asst. Engr. of Tests, State Highway Comm., Bureau of Materials and Tests (Res., 2613 Broadway St., Apartment 8), Indianapolis, Ind.

BROWN, WILLIAM ISAAC (Assoc. M. '36), Asst. Engr., U. S. Bureau of Reclamation (Res., 1145 Sherman St.), Denver, Colo.

BROWNELL, WILLIAM FRED, JR. (Jun. '35), 302 Lake Ave., Ithaca, N.Y.

CARTER, ARCHIE NEWTON (Jun. '36), Junior Engr., U. S. Engr. Office, War Dept., Rock Island, Ill.

COLB, HOWARD THOMAS (M. '36), State Engr. Insp. for Alabama, Georgia and Florida, Room 730 Citizens & Southern Bank Bldg., Atlanta, Ga.

COX, GEORGE WALTER (Jun. '35), Dept. of Civ. Eng., Agri. and Mech. Coll. of Texas, College Station, Tex.

DIMOCK, ASA REDMOND, JR. (Jun. '35), Naval Air Station, Pensacola, Fla.

DOUMA, JACOB HENDRICK (Jun. '36), Gauge Reader, Mississippi River Comm. (Res., 1100 Crawford St.), Vicksburg, Miss.

DUERR, ARLIE WILLIAM (Jun. '35), 531 South Main St., Orrville, Ohio.

DUMBLE, CHARLES SKILES (Jun. '35), 2129 Twenty-Second St., Bakersfield, Calif.

EDMANDS, HORACE JOHN (Jun. '35), Box 176, Temperance, Mich.

ENNIS, WILLIAM DUANE (M. '36), Alexander Crombie Humphreys Prof. of Economics of Eng., and Head of Dept., Stevens Inst. of Technology, Hoboken, N.J.

FAXON, ALFRED AUSTIN, JR. (Jun. '36), Junior Engr., State Highway Dept. (Res., 2 South Clinton Ave.), Trenton, N.J.

FITCH, HORATIO MAY (Assoc. M. '36), Instr. in Civ. Eng., North Dakota Agri. Coll., Fargo, N.Dak.

FRAGA, GEORGE PABLO (Jun. '36), Asst. Estimator, North Eastern Constr. Co., New York (Res., 173 Lafayette Ave., Brooklyn), N.Y.

TOTAL MEMBERSHIP AS OF APRIL 9, 1936	
Members	5,718
Associate Members	6,175
Corporate Members	11,893
Honorary Members	21
Juniors	3,194
Affiliates	95
Fellows	2
Total	15,205

GARCIA MONTES, José (M. '36), Chf. Designing Engr., Havana Water Works (Res., Avenida de Belgica 4), Havana, Cuba.

GRANGER, RAYMOND OSCAR (Jun. '35), 894 Grafton St., Worcester, Mass.

GREER, SYDNEY ROBERT (Jun. '35), Care, Maintenance Dept., State Highway Dept., Austin, Tex.

GRUNTER, PAUL CHARLES (Jun. '36), Technical Asst., Mass. Inst. of Tech., Cape Cod Canal Research, U. S. Engr. Dept., Boston (Res., 260 Foster St., Brighton), Mass.

HARTLEY, ROBERT WILLARD (Jun. '35), Research Asst., Research Committee on Urbanism, 1125 Carew Tower, Cincinnati, Ohio.

HELLER, FREDERIC ALBERT (Jun. '35), 419 North State St., Ann Arbor, Mich.

HERZBERG, NOBLE WILLIAM (Jun. '35), Junior Engr., Hydr., U. S. Geological Survey (Res., 31 Stanwix St.), Albany, N.Y.

JOERNS, JOHN O'BRIEN (Jun. '35), 619 North 3d St., Albuquerque, N.Mex.

JOHNSTON, ROY GUNNAR (Jun. '35), 2012 South Curtis St., Alhambra, Calif.

JORISSEN, ANDRE LAURENT (Jun. '36), Runkle 204, Mass. Inst. of Tech. Dormitories, Cambridge, Mass.

KRAHMER, EDWARD AUGUST (Jun. '35), With TVA, Guntersville, Ala.

KRIEGEL, BENJAMIN (Assoc. M. '36), Res. Engr. Insp., PWA, 424 East 110th St. (Res., 97 Fort Washington Ave.), New York, N.Y.

KROHN, AUGUST FREDERICK (Jun. '35), 2858 Kingsbridge Terrace, New York, N.Y.

LAIRD, ARTHUR EDWARD (Jun. '35), Topographic Draftsman, U. S. Eng. Dept., 415 South Rankin St., Natchez, Miss.

LEFEVRE, WILLIAM DOUGLAS (Assoc. M. '36), Chf. Insp., Kent Island Bridge, Chesapeake City, Md.

LESLIE, DANA DALE (Jun. '36), Instr., Dept. of Civ. Eng., North Dakota State Coll., Fargo, N.Dak.

LYNN, PATRICK IGNATIUS (Jun. '35), Care, International Harvester Co., Syracuse, N.Y.

MACKENZIE, WILLIAM BIGELOW (Assoc. M. '36), Asst. Bridge Engr., St.L.-S. F. Ry. (Res., 408 Loren St.), Springfield, Mo.

MCARTHUR, CLAIRE LUVOICE, JR. (Jun. '35), Asst., Arkansas Natural Gas Co. (Res., 3420 Youree Drive), Shreveport, La.

MCCUNE, FREDERICK LEO (Jun. '35), 2015 West 62d St., Seattle, Wash.

MARANE, ALFRED CARL (Jun. '36), Eng. Draftsman, TVA (Res., 641 Battery Pl.), Chattanooga, Tenn.

MARCHANT, ORSON HILL (M. '36), Vice-Pres. and Secy., Blair & Marchant, Inc. (Res., 241 Alden Ave.), New Haven, Conn.

MARTIN, FRANK LYSANDER (Assoc. M. '36), Prof., Civ. Eng. and Head, Dept. of Eng., Pennsylvania Military Coll. (Res., 143 Parkway Ave.), Chester, Pa.

MASI, FELIX JOSEPH (Jun. '35), 20 Boulevard, Summit, N.J.

MILLER, CYRIL JOSEPH (Jun. '36), 1553 Maple St., Dubuque, Iowa.

MOLLOY, JOHN JOSEPH (Jun. '35), Instrumentman, Industrial Rehabilitation Div., Blackstone River Val. Project; 6 Mendon St., Worcester, Mass.

MOORE, CHARLIE MARTIN (Jun. '35), Junior Agri. Engr., SCS, Lindale, Tex.

MOORE, AUGUST JOSEPH (Jun. '35), 5040 Haverford Ave., Philadelphia, Pa.

MORRIS, ROBERT BEVERLY (Jun. '36), Junior Civ. Engr., U. S. Forest Service, 4836 New Hampshire Ave., Washington, D.C.

MURRAY, EVERETT WEBB (Jun. '35), Wright City, Okla.

PENN, JOHN CORNELIUS (M. '36), Director of Civ. Eng. Option, Armour Inst. of Technology, 3300 Federal St., Chicago, Ill.

PEPPERMAN, CECIL MALLORY (Assoc. M. '36), Draftsman, State Dept. of Highways (Res., 456 Curtin St.), South Williamsport, Pa.

PFEFFER, JOSEPH (Jun. '36), Insp., U. S. Army Engrs., Box 14, Genoa, Wis.

PINE, CHARLES ADAM (Jun. '36), Res. Engr., Charles A. Haskins (Res., 3209 Broadway, Apartment 18), Kansas City, Mo.

ROBINSON, GEORGE VINTON (M. '36), Engr., Baar & Cunningham, 414 Spalding Bldg., Portland, Ore.

ROHRER, GEORGE HILLDRING (Jun. '36), Project Supt., Morris County Planning Comm., WPA, Morristown (Res., 21 Cobb Rd., Mountain Lakes), N.J.

ROSENGARTEN, CARL ALFRED (Assoc. M. '36) Structural Engr., Office of Superv. Archt., U. S. Treasury Dept., Washington, D.C. (Res. 515 Oxford Rd., Brookline, Pa.)

RUSSELL, ALEXANDER DAVID (Jun. '36), 2712 Stuart St., Berkeley, Calif.

SEAMAN, AMBROSE CLEAVER (Assoc. M. '36), Engr., B. H. Constr. Co., 31-11 Fifty-Fifth St., Woodside (Res., 35–15 One Hundred and Sixty-Fourth St., Flushing), N.Y.

SMITH, LAWRENCE WESLEY (Affiliate '36), Forest Products Engr., National Lumber Mfrs. Assoc., 1337 Connecticut Ave., N.W. (Res., 1315 New Hampshire Ave., N.W.), Washington, D.C.

STEWART, LUTHER WASHINGTON (Assoc. M. '36), Asst. County Highway Engr., Washington County (Res., 307 South Theobold St.), Greenville, Miss.

STINSON, ORVIS DANIEL (Jun. '36), Senior Draftsman, State Highway Comm., Raleigh, N.C.

TARLTON, ELLIS ALVORD (Jun. '35), 22 Oldfield Rd., Fairfield, Conn.

THOM, PAUL GEORGE (Jun. '36), Under Eng. Aide, Eng. Service Div., TVA, La Follette, Tenn.

THOMPSON, ROBERT JACKSON (Jun. '35), 708 Cherry St., Atlanta, Ga.

VENNARD, JOHN KING (Jun. '36), Instr. in Hydraulics, New York Univ. (Res., 1950 Andrews Ave.), New York, N.Y.

WEAKLEY, SAMUEL ANDERSON (M. '36), Engr., U. S. Engr. Office (Res., 2901 Westmoreland Drive), Nashville, Tenn.

WEED, SAM ALLEN (Jun. '36), With City of Oakland, Eng. Dept., Oakland (Res., 2400 Durant Ave., Berkeley), Calif.

WILLEY, CHARLES KEITH (Jun. '36), Draftsman, Design Dept., State Highway Comm., Masonic Bldg. (Res., 313 East 9th St.), Topeka, Kans.

WITZIG, BERARD JOHN (Jun. '35), 114 West 109th St., New York, N.Y.

WOJCIK, THEODORE AUGUSTUS (Jun. '35), Hotel General Lenoir, Lenoir City, Tenn.

YOUNG, TRUMAN PADDACK (Assoc. M. '36), Structural Engr., City of Cincinnati (Res., 3642 Shaw Ave.), Cincinnati, Ohio.

MEMBERSHIP TRANSFERS

BERRY, CARL MORRISON (Jun. '31; Assoc. M. '36), Geodetic and Cadastral Engr., Chf. of Triangulation Surveys, U. S. Bureau of Reclamation, Box 407, Davenport, Wash.

BIRNBAUM, HARRY (Jun. '30; Assoc. M. '36), Care, U. S. Forest Service, Dist. Ranger Office, Berea, Ky.

BUCHANAN, JESSE EVERETT (Jun. '27; Assoc. M. '35), Testing Engr., Idaho Bureau of Highways; Asst. Prof., Civ. Eng., Univ. of Idaho, Box 301, Moscow, Idaho.

CROWELL, SIDNEY HOWE (Jun. '28; Assoc. M. '36), Junior Engr., U. S. Engr. Office, Huntington, W.Va.

FENN, NATHAN FREDERICK, JR. (Jun. '27; Assoc. M. '35), Vice-Pres., South Bay Consolidated Water Co., Inc., Box 601, Bay Shore, N.Y.

FONT, GILBERTO MELQUIADES (Jun. '32; Assoc. M. '35), Res. Engr., Dist. of San Juan, Div. of Constr., Maintenance and Repair, Insular Roads and Bridges, Dept. of the Interior, Box 732, Rio Piedras, Puerto Rico.

KIMBALL, WILLIAM PHELPS (Jun. '29; Assoc. M. '36), Instr., Civ. Eng., Thayer School of Civ. Eng., Hanover, N.H.

KING, DONALD DOMINICK (Jun. '30; Assoc. M. '36), With Am. Soc. C.E., 33 West 39th St., New York, N.Y.

MCLAUGHLIN, EDWARD DENNIS (Jun. '28; Assoc. M. '36), Asst. Engr., Building Design Div., Eastman Kodak Co., Bldg. 23, Rochester, N.Y.

RAAB, NORMAN CECIL (Jun. '22; Assoc. M. '26; M. '36), Superv. Bridge Designing Engr., San Francisco–Oakland Bay Bridge, 500 Sansome St., San Francisco, Calif.

RICE, CLAUDE HAYES (Jun. '32; Assoc. M. '36) Project Supt., U. S. Forest Service, Peru, Vt.

RIPPSTEIN, JOHN (Jun. '28; Assoc. M. '35), 422½ East Seneca St., Ithaca, N.Y.

SANDS, ROBERT LAWRENCE (Assoc. M. '25; M. '36), Asst. Engr., New York Edison Co., Inc., 4 Irving Pl., Room 1509 S, New York, N.Y.

SCOTT, MARION BURDICK (Jun. '29; Assoc. M. '35), 601 East Foothill Boulevard, Rialto, Calif.

SELBY, CHARLES ARTHUR (Jun. '30; Assoc. M. '36), Secy. and Treas., Wininger & Selby, Inc., 152 West 42d St., New York, N.Y.

STURTEVANT, MERRILL HOUSTON (Jun. '25; Assoc. M. '35), Asst. Engr., Syracuse Grade Crossing Comm. (Res., 131 Craddock St.), Syracuse, N.Y.

WESTBY, HARVEY ORLANDO (Jun. '27; Assoc. M. '36), Asst. Engr., U. S. Engr. Dept., 627 Pittock Blk. (Res., 715 South West King Ave.), Portland, Ore.

WINTZ, EDWARD RAMSEY (Jun. '34; Assoc. M. '36), Asst. Engr., Met. Water Dist. of Southern California, Box A, Banning (Res., 3208 Mulberry St., Riverside), Calif.

REINSTATEMENTS

BERG, FRANK ANTON, Assoc. M., reinstated Mar. 9, 1936.

CRAUSMAN, MORRIS ARTHUR, Jun., reinstated Mar. 5, 1936.

FRIEDMAN, EDMUND, Assoc. M., reinstated Feb. 26, 1936.

KAMMER, JOSEPH IVAN, Assoc. M., reinstated Feb. 28, 1936.

MILES, HENRY JAMES, Jun., reinstated Feb. 27, 1936.

SCOTT, SILAS STEELE, Jun., reinstated Feb. 13, 1936.

RESIGNATIONS

MATHEWSON, JOHN, Jun., resigned Feb. 5, 1936.

PIERCE, VERNON MARSHALL, M., resigned Mar. 2, 1936.

ROWAN, WILLIAM HAMILTON, Jun., resigned Feb. 18, 1936.

WESTON, FREDERICK SAMPSON, Assoc. M., resigned Feb. 17, 1936.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

April 1, 1936 NUMBER 4

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

ABEL, STANFORD EDWARD, Washington, D.C. (Age 34.) Supt., Hechinger Co. Refers to, F. F. Gillen, N. A. Melick, J. W. Oehmann, C. A. Peters, Jr., A. J. Scullen.

AUERBACH, ALVIN BERTHOLD, Rock Island, Ill. (Age 26.) Jun. Engr., U. S. Engr. Office. Refers to J. B. Bassett, W. C. Huntington, R. L. Stevens, H. P. Warren, H. M. Westergaard.

BARBITT, BENJAMIN TALBOT, JR., Sacramento, Calif. (Age 27.) Refers to F. A. Barnes, H. H. Hodgeson, R. R. Monbeck.

BARTON, ROBERT RANDOLPH, Charleston, W.Va. (Age 42.) Res. Engr. with C. P. Fortney, Cons. Engr. Refers to R. P. Davis, C. P. Fortney, G. H. Hill, T. A. Polansky, J. E. Settle, P. J. Walsh.

BESOZZI, LEO, Hammond, Ind. (Age 33.) Superv. Civ. Engr., Dept. of Water-Works. Refers to E. A. Clark, A. W. Consoer, J. L. Crane, Jr., P. Hansen, W. E. Stanley, L. G. Williams.

BEST, JAMES ARTHUR, Mays Landing, N.J. (Age 32.) Jun. Engr., New Jersey State Highway Dept. Refers to M. W. Grimes, B. P. Larkin, E. H. Maier, E. W. Packer, C. D. Weller.

BLINN, RAY SHARP, New Smyrna, Fla. (Age 65.) Res. Engr. Inspector, PWA. Refers to H. D. Mendenhall, C. T. Morris, E. G. Robinson, C. E. Sherman, G. E. Thackray.

BURACK, WILLIAM DURWOOD, Livingston, N.J. (Age 28.) Engr., Wallace & Tiernan Co. Refers to H. N. Cummings, W. S. LaLonde, Jr., N. K. Torsky, C. R. Wyckoff, S. F. Yasines.

CABANISS, LESLIE DAVIS, Sulphur Springs, Tex. (Age 33.) Project and Res. Engr., Texas State Highway Dept. Refers to C. C. Cagle, F. M. Davis, W. D. Dockery, A. D. Hutchison, H. H. Peel, J. E. Piric, A. P. Rollins.

CAMERON, DONALD WILBER, Gainesville, Fla. (Age 21.) Refers to T. M. Lowe, P. L. Reed.

CAMERON, GEORGE CLIFTON, Oak Park, Ill. (Age 39.) Treas. and Chf. Engr., Municipal Eng. & Equipment Co. Refers to L. G. Cutler, A. T. Ricketts, A. L. Sherman, F. H. Stephenson, R. H. Tatlow, 3d.

CAROLLO, JOHN ANDREW, Phoenix, Ariz. (Age 30.) Junior member, Headman-Ferguson Engrs. Refers to J. A. Fraps, S. A. Greeley, C. E. Griggs, P. Hansen, H. A. Olson, H. S. Reed, J. H. Rider, W. E. Stanley.

CHAPIN, RICHARD NORMAN, New York City. (Age 33.) Asst., Applied Eng. Dept., Air Reduction Sales Co. Refers to C. V. Britton, M. E. Gilmore, R. C. Hardman, V. H. Hewes, J. A. L. Waddell.

CIOCHETTO, FRANK CHARLES, Pueblo, Colo. (Age 22.) With WPA. Refers to C. L. Eckel, E. W. Raeder.

CLARK, EDWARD ALLIS, Poughkeepsie, N.Y. (Age 34.) Dist. Engr., Socony-Vacuum Oil Co. Refers to H. B. Alvord, A. W. Bacon, H. W. Buck, C. S. Ell, H. W. Griswold, S. Hargen, B. B. Lewis.

DAHL, HARRY WALTER, Salt Lake City, Utah. (Age 24.) Rodman and Draftsman, Utah State Road Comm. Refers to T. C. Adams, M. Housecroft, R. B. Ketchum, K. C. Wright.

DEVIDO, LEWIS ANDREW, New Brunswick, N.J. (Age 28.) Jun. Civ. Engr., ECW, CCC Camp, Port Republic, N.J. Refers to H. N. Lendall, W. Rudolfs.

DOUGHERTY, DANIEL MICHEAL, Memphis, Tenn. (Age 35.) Executive Engr. and Project Mgr. S & W Constr. Co. Refers to G. A. Amberg, G. M. Baker, F. V. Ragsdale, E. E. Schmied, F. W. Truss.

DOWNING, CLAIRE ANSEL, St. Louis, Mo. (Age 36.) Engr.-in-Charge, Municipal Testing Laboratory. Refers to W. C. E. Becker, R. B. Brooks, H. E. Frech, R. P. Garrett, H. C. Halley, L. A. Pettus, R. A. Willis.

ERICKSON, ERICK BOINE, Washington, D.C. (Age 30.) Jun. San. Engr., Constr. Div., Resettlement Administration. Refers to K. K. King, F. J. Laverty, C. J. Suhr, A. M. Wyman, F. C. Zeigler.

ESPY, CECIL JEFFERSON, JR., Portland, Ore. (Age 24.) Recorder, U. S. Army Engrs. Refers to T. W. Espy, J. R. Griffith, F. Merryfield, C. A. Mockmore, L. D. Williams, Jr.

FASSHAUER, WALTER HENRY, Philadelphia, Pa. (Age 43.) Pres., Bear Eng. & Constr. Co. Refers to R. F. Buck, L. E. Cambios, J. Cantley, L. L. Lessig, W. F. Newbery, C. H. Wurster, Jr.

FRANCISCO, STEPHEN COOKE, Montclair, N.J. (Age 26.) Asst. to Roger Coupe, Prof. Engr. and Land Surveyor, Paterson, N.J. Refers to G. E. Barrows, W. S. Lohr, L. Perry, E. H. Rockwell, G. F. Roehrig.

GELBERMAN, JACOB, Brooklyn, N.Y. (Age 26.) Refers to W. A. Coolidge, F. J. Lewis.

GLANDING, JAMES HENRY, Philadelphia, Pa. (Age 34.) Engr. and Estimator, Tilghman Moyer Co., Allentown, Pa. Refers to G. F. Alderson, J. J. Grelis, Jr., S. S. A. Keast, T. H. Moyer, W. R. Sauter.

GLASGOW, CHARLES, JR., Sausalito, Calif. (Age 24.) Engr. with Asa G. Proctor, Cons. Structural and Civ. Engr., Woodland, Calif. Refers to E. L. Grant, J. O. Miller, A. S. Niles, A. G. Proctor, J. B. Wells.

GORDON, RONALD ARTHUR, McConnelsville Ohio. (Age 26.) Asst. Engr., Ohio State Highway Dept. Refers to J. M. Montz, R. C. Sloane.

GRIFFITH, JOHN OAKLEY, Mt. Vernon, Ohio. (Age 23.) Draftsman, Mt. Vernon Bridge Co. Refers to G. E. Large, C. T. Morris, J. R. Shank, C. E. Sherman, R. C. Sloane.

HARDEN, MILTON JONES, Washington, D.C. (Age 41.) With U. S. Geological Survey, Rolla, Mo. Refers to C. E. S. Bardsley, J. B. Butler, H. K. Rubey, C. L. Sadler, G. S. Smith, J. G. Staack.

ISE, HENRY, Providence, R.I. (Age 35.) Asst. Engr., Dept. of Public Works. Refers to S. M. Dore, C. A. Maguire, F. B. Marsh, W. W. Peabody, M. Pirnie, R. W. Sawyer, 3d, F. E. Waterman, S. Wilmot, F. E. Winsor.

JENSON, THEODORE BRUCE, Minneapolis, Minn. (Age 26.) Designing Engr., PWA Project Engr.'s Office, Minneapolis-St. Paul San. Dist. Project. Refers to F. Bass, W. N. Carey, A. J. Duvall, M. S. Grytbak, M. W. Hewett, J. L. Parcel, W. H. Sleeger.

JOHNSON, BERNARD DAVID, Keyser, W.Va. (Age 43.) Acting Dist. Engr., West Virginia State Road Comm., Charleston, W.Va. Refers to J. P. Blundon, C. P. Fortney, J. R. McDermott, J. K. McGrath, B. H. Simpson, M. W. Smith, Jr., C. Swecker.

KENNEDY, DANIEL, Washington, D.C. (Age 36.) Assoc. Topographic Engr., U. S. Geological Survey, Rolla, Mo. Refers to C. E. S. Bardsley, J. B. Butler, E. F. Chandler, E. G. Harris, H. H. Hodgeson, C. L. Sadler, G. S. Smith.

KITTRELL, CLARK, Ft. Peck, Mont. (Age 43.) With U. S. Engrs., Ft. Peck Dam. Refers to G. R. Clemens, L. C. Hill, T. B. Larkin, T. Merriman, P. S. Reinecke, K. R. Young.

LEONARD, GEORGE KINNEY, Joe Wheeler Dam, Ala. (Age 46.) Asst. Constr. Engr., TVA. Refers to C. A. Bock, F. T. Darrow, J. G. Mason, B. S. Philbrick, D. D. Price.

MCCOY, HERBERT VIRGIL, Collinsville, Ill. (Age 38.) Asst. Constr. Engr., Illinois Div. of Highways. Refers to C. H. Apple, F. H. Eno, C. M. Hathaway, C. T. Morris, G. B. Richardson, C. E. Sherman, R. C. Sloane, H. J. Spelman.

MCFADDEN, JOHN JOSEPH, Brooklyn, N.Y. (Age 27.) Field Engr., Board of Transportation, New York City. Refers to M. Hendee, F. A. Rossell, C. T. Schwarze, J. Wilmot, A. M. Wyman.

MADSEN, INGVALD ELIAS, Bethlehem, Pa. (Age 24.) American Inst. of Steel Constr. Research Fellow, Lehigh Univ. Refers to I. M. Lyse, C. H. Sutherland.

MARSHALL, FREDERICK LEONARD, JR., Harrison, N.Y. (Age 24.) Superv. Engr., WPA, White Plains, N.Y. Refers to R. A. Hall, A. D. Hoadley, H. Miller, N. Penna, A. Richards, W. C. Taylor.

MASCOTT LOPEZ, LUIS, Mexico, D.F., Mexico. (Age 35.) On engineering and sales with Westinghouse Elec. International Co.; Prof. of Elec. Eng. for Civ. Engrs., Facultad Nacional de Ingenieros; Representative before Mexican Govt. for Monterrey Railway, Light and Power Co. Refers to G. D. Camp, J. Chavez-Orozco, G. R. G. Conway, A. Peimbert, S. V. Perez.

MATTESON, ELDON FRANKLIN, Unadilla Forks, N.Y. (Age 21.) Refers to R. W. Abbett, R. A. Hall, B. B. Sousley, W. W. Studdert, W. C. Taylor.

MATTHEWS, CHARLES WILLIAM, Milwaukee, Wis. (Age 31.) Associate Town Planner, Suburban Resettlement Div., Resettlement Administration. Refers to W. F. Cavanaugh, G. F. Daggett, C. Jenkins, G. W. Rauch, H. C. Webster.

MILLEN, VINCENT LADDIE, Jacksonville, Fla. (Age 27.) Jun. Salesman, Jones & Laughlin Steel Corporation, Atlanta, Ga. Refers to R. P. Black, F. C. Snow.

NESSLER, CHARLES WILLIAM HENRY, Glendale, Calif. (Age 45.) Associate Engr., U. S. Geological Survey. Refers to C. H. Birdseye, W. R. Chenoweth, H. H. Hodgeson, A. Jones, J. G. Staack.

NUNUM, CHARLES RICHARD, Romney, W.Va. (Age 28.) Jun. Engr., State Road Comm. Refers to A. O. Babb, L. V. Carpenter, M. Cilley, R. P. Davis, W. S. Downs, J. R. McDermott, C. Swecker.

O'LOUGHLIN, THOMAS JOHN, St. Paul, Minn. (Age 23.) Refers to F. Bass, A. S. Cutler, O. M. Leland, L. G. Straub.

PENDLETON, WILLIAM LAMAR, Phoenix, Ariz. (Age 40.) Chf. Draftsman and Asst. Engr. of Plans, Arizona Highway Dept. Refers to W. H. Becker, R. A. Hoffman, V. H. Householder, W. R. Hutchins, R. V. Leeson, G. L. McLane, E. V. Miller.

PERROTT, THELO ALBERT, Palo Alto, Calif. (Age 35.) Asst. City Engr. Refers to J. F. Byrnee, S. A. Chapman, J. L. Mason, C. Moser, J. G. Rawhauser, L. B. Reynolds, E. C. Thomas.

PFEIFER, FREDERICK JOSEPH, Keyser, W.Va. (Age 34.) Inspector-in-Charge with State Road Comm. Refers to A. O. Babb, W. Brewster, J. R. McDermott, J. K. McGrath, B. H. Simpson, C. Swecker.

PHILBRICK, WILLIAM HUNT, Keene, N.H. (Age 26.) Chf. of Survey Party, New Hampshire Highway Dept. Refers to J. W. Childs, F. E. Everett, L. F. Johnson, L. C. Marshall, A. E. White.

PICCHI, FERRER, Tuckahoe, N.Y. (Age 26.) Asst. to Gen. Field Supt., WPA, New York City. Refers to A. L. Hausmann, C. T. Schwarze, H. B. Wheatcroft, Jr.

PRICE, THOMAS MOORE, Oakland, Calif. (Age 45.) With Henry J. Kaiser and various component companies. Refers to A. H. Ayers, R. E. Davis, C. Derleth, Jr., C. R. Gow, T. F. Hickerson, J. M. Page, O. W. Peterson, J. F. Sanborn, J. L. Savage, W. R. Young.

RESTALL, ROBERT SIDNEY, Cambridge, Mass. (Age 22.) Graduate student, Harvard Sanitary Eng. School. Refers to H. P. Burden, G. M. Fair, F. N. Weaver.

REYNOLDS, JOHN THOMAS, Independence, Mo. (Age 26.) Draftsman with Black & Veatch, Cons. Engrs., Kansas City, Mo. Refers to N. L. Ashton, E. B. Black, W. G. Fowler, C. S. Harper, E. E. Howard, A. Ramey, H. C. Tammen, N. T. Veatch, Jr.

ROBINSON, GEORGE NORMAN, New York City. (Age 43.) Pres., Equity Constr. Co., Inc., Engrs. and Contrs. Refers to J. F. Friebele, S. Hargen, H. A. Kelly, E. A. Prentis, M. N. Shoemaker, W. A. Stickel.

ROCKEFELLER, EDWARD JOHN, Hamden, Conn. (Age 27.) Chf. of Party with Connecticut State Highway Dept. Refers to C. T. Bishop, C. M. Blair, W. N. Brown, C. S. Farnham, O. H. Marchant, R. H. Suttie, J. C. Tracy.

RUSSELL, JOHN CRITTENDEN, Fredericksburg, Va. (Age 32.) With Suburban Resettlement Administration. Refers to H. A. Abildso, R. B. H. Begg, H. W. Bressler, J. H. Burgoyne, H. B. Bursley, A. E. S. Hall, W. L. Milner, F. J. Sette.

SMITH, THOMAS ALEXANDER, Olton, Tex. (Age 30.) Office Engr., Div. No. 5, Texas State Highway Dept. Refers to G. A. Field, J. A. Focht, W. H. Garrett, L. C. Ingram, Jr., H. N. Roberts, J. W. Stewart, J. E. Taylor.

STOUT, DAVID LESTER, Lawrenceville, N.J. (Age 29.) Computer, U. S. Coast & Geodetic Local Control Survey. Refers to H. B. Alvord, J. F. W. Gebhardt, P. B. Heidema, J. W. Ingalls, P. Kissam, E. Pendlebury.

STRONG, CHARLES HENDERSON, San Francisco, Calif. (Age 26.) Draftsman and Estimator with Fred H. Tibbetts, Civ. Engr. Refers to E. E. Blackie, L. L. Carter, E. L. Grant, H. H. Hall, C. A. Strong, F. H. Tibbetts.

VOLL, RAYMOND MANUAL, Knoxville, Tenn. (Age 25.) Jun. Eng. Aide, TVA. Refers to W. J. Carrel, W. M. Jarvis, D. V. Terrell.

VOSE, ROBERT WESTON, Cambridge, Mass. (Age 25.) Instructor in Mech Eng., Massachusetts Inst. of Technology. Refers to C. B. Breed, E. L. Eriksen, D. Peabody, Jr., C. M. Spofford, W. C. Voss.

WHALLEY, ALBERT EDWARD, JR., Nashville, Tenn. (Age 23.) Res. Engr., Water-works and sewers, Freeland, Roberts and Co. Refers to W. A. Coolidge, L. R. Currey, Jr., F. J. Lewis.

WHITE, MERIT PENNIMAN, Altadena, Calif. (Age 27.) Jun. Conservationist, Soil Conservation Service. Refers to R. T. Knapp, R. R. Marsden, R. R. Martel, F. Thomas, J. von Karman.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BARNES, HUGH DONALD, Assoc. M., Topeka, Kans. (Elected July 12, 1926.) (Age 39.) State Highway Engr. (Chf. Eng. Executive), State Highway Comm. of Kansas. Refers to E. Boyce, L. E. Conrad, F. W. Epps, F. F. Frazier, G. S. Knapp, R. J. Paulette.

BERRYMAN, RUSSELL GARDNER, Assoc. M., Philadelphia, Pa. (Elected July 16, 1928.) (Age 42.) Engr., Day & Zimmerman, Inc. Refers to H. E. Ehlers, J. A. Emery, C. E. Myers, H. H. Quimby, W. R. Scanlin, C. H. Stevens, W. S. Twining.

CLARK, HOWARD FOSTER, Assoc. M., Washington, D.C. (Elected Junior Dec. 2, 1914; Assoc. M. Sept. 12, 1916.) (Age 50.) Capt., Civil Engineering Corps, U. S. Army; Asst. Engr. Commr. (Executive Officer), CWA, EWA, and WPA. Refers to M. H. Brinkley, H. F. Clemmer, J. C. Gotwals, J. B. Gordon, G. S. Hinckley, F. C. Squire, C. H. Tompkins, H. C. Whitehurst.

DORE, STANLEY MILBURN, Assoc. M., Dedham, Mass. (Elected Feb. 10, 1930.) (Age 37.) Asst. Designing Engr. and Associate Civ. Engr., Metropolitan Dist. Water-Supply Comm. of Massachusetts, Boston, Mass. Refers to R. S. Holmgren, K. R. Kennison, F. B. Marsh, W. W. Peabody, S. Wilmot, F. E. Winsor.

MAVIS, FREDERIC THEODORE, Assoc. M., Iowa City, Iowa. (Elected Junior Jan. 15, 1923; Assoc. M. Nov. 15, 1926.) (Age 35.) Prof. and Acting Head of Dept. of Mechanics and Hydraulics, and Associate Director, Iowa Inst. of Hydraulic Research, State Univ. of Iowa. Refers to H. Cross, M. L. Enger, B. J. Lambert, C. A. Mockmore, L. G. Straub, C. C. Williams, S. M. Woodward.

REED, OREN, Assoc. M., Pickwick Dam, Tenn. (Elected Junior Jan. 14, 1924; Assoc. M. Oct. 10, 1927.) (Age 40.) Asst. Constr. Engr. TVA, Knoxville, Tenn. Refers to H. K. Fox, W. K. Hatt, W. A. Knapp, R. F. Olds, A. L. Pauls, R. M. Riegel.

WRIGHT, CHILTON AUSTIN, Assoc. M., Washington, D.C. (Elected Junior April 3, 1922; Assoc. M. Nov. 14, 1927.) (Age 37.) Associate Engr., Hydr. Laboratory, National Bureau of Standards. Refers to C. A. Betts, J. P. Hogan, J. R. Lapham, T. W. Marshall, D. E. Parsons, F. W. Scheidenhelm, E. W. Schoder.

FROM THE GRADE OF JUNIOR

BEERMANN, PAUL, Jun., San Diego, Calif. (Elected March 14, 1927.) (Age 31.) Engr., Div. of Development and Conservation, Water Dept., City of San Diego. Refers to J. V. Jewett, H. W. Jorgensen, F. D. Pyle, L. B. Reynolds, H. I. Wood.

BLUMBERG, OSCAR CHARLES, Jun., Concord, Calif. (Elected Jan. 16, 1928.) (Age 32.) Chemist (with duties of Purification Engr.), California Water Service Co., Martinez, Calif. Refers to A. C. Beyer, R. F. Brown, C. G. Gillespie, H. A. Harris, Jr., C. G. Hyde, J. A. Wade.

BOWERS, SAMUEL WARREN, Jun., Southington, Conn. (Elected Aug. 17, 1931.) (Age 32.) MacKenzie & Bowers, Engrs. and Surveyors. Refers to C. M. Blair, J. D. Brown, E. T. Nettleton, W. J. Scott, J. P. Wadhams.

CLARK, ROY JAMES, Jun., Mohegan Lake, N.Y. (Elected Oct. 1, 1928.) (Age 32.) Refers to B. A. Batson, J. W. Bradner, Jr., D. W. Carmichael, G. H. Elbin, A. R. Webb.

CRITSER, WILLIAM HAROLD, Jun., Columbus, Ohio. (Elected March 5, 1928.) (Age 32.) Designing Engr. with City of Columbus. Refers to R. A. Allton, O. Bonney, J. H. Gregory, D. T. Mitchell, C. T. Morris, R. T. Regester, J. A. Rousculp, F. D. Stewart, F. E. Swineford.

EASON, RALPH LEE, Jun., St. Louis, Mo. (Elected June 9, 1930.) (Age 32.) Civ. Engr., Board of Public Service. Refers to A. H. Baum, Jr., B. L. Brown, L. A. Hoynck, C. A. Koerner, C. W. S. Sammelman, E. O. Sweetser, J. L. Van Ornum.

EVANS, WILLIAM NORMAN, Jun., Glendale, Calif. (Elected Nov. 10, 1930.) (Age 33.) Chf. of Party and Estimator, Hydr. Div., Metropolitan Water Dist. of Southern California. Refers to R. L. Anderson, H. R. Bolton, R. B. Diemer, W. B. Evans, D. S. Hayes, T. R. Mini.

FENWICK, KENNETH MACDONALD, Jun., Los Angeles, Calif. (Elected Oct. 14, 1929.) (Age 32.) Asst. Res. Engr. of Constr., California Div. of Highways, Dist. VII, Los Angeles. Refers to H. Conkling, F. B. Cressy, A. N. George, G. B. Gleason, F. H. Hay, W. P. Rowe, F. Thomas.

GAIN, ELMER WILLIAM, Jun., Milwaukee, Wis. (Elected Oct. 14, 1930.) (Age 30.) Administrative Eng. Asst. to Dist. Engr., Bureau of Agricultural Eng., U. S. Dept. of Agriculture. Refers to H. E. Frech, R. W. Jablonsky, C. E. Jacoby, E. M. Kniestedt, L. A. Pettus, E. O. Sweetser, J. L. Van Ornum, R. A. Willis.

GREENFIELD, ISADORE, Jun., Lexington, Ky. (Elected Dec. 5, 1927.) (Age 31.) With H. K. Gatley, Res. Engr. for Fuller & McClintock, Cons. Engrs., on work for City of Lexington. Refers to W. J. Carrel, H. K. Gatley, C. J. Kennedy, D. V. Terrell, R. H. Wilson.

HARROLD, LLOYD LARREN, Jun., Washington, D.C. (Elected Oct. 14, 1930.) (Age 28.) Asst. Hydr. Engr., Soil Conservation Service, U. S. Dept. of Agriculture. Refers to M. M. Bernard, R. W. Davenport, N. C. Grover, J. C. Hoyt, W. G. Hoyt, C. G. Paulsen.

LEAK, HOWARD SWINK, Jun., Grand Canyon, Ariz. (Elected Oct. 10, 1927.) (Age 32.) Asst. Engr. Water Resources Branch, U. S. Geological Survey. Refers to D. H. Barber, J. A. Baumgartner, H. P. Boardman, C. M. Carrel, W. E. Dickinson, J. S. Gatewood, M. R. Tillotson.

OSBORN, LEWIS KNOWLES, Jun., Long Beach, Calif. (Elected Oct. 14, 1929.) (Age 32.) Structural Engr. with T. C. Kistner, Archt., Los Angeles, Calif. Refers to H. G. Balcom, J. L. Edwards, L. R. Hjorth, R. J. Kadow, C. C. More, W. F. Way, W. T. Wright.

REED, RALPH, Jun., Watertown, S.Dak. (Elected March 5, 1928.) (Age 31.) Asst. City Engr. Refers to H. S. Carter, E. D. Dake, A. Diefendorf, J. E. A. Linders, E. H. Quinney. J. C. Rathbun.

RODICHAU, HAROLD VINCENT, Jun., Beverly, Mass. (Elected Nov. 15, 1926.) (Aged 32.) Asst. Engr. (WPA), Public Works Dept. Refers to R. W. Burpee, G. Gilboy, F. A. Marston, A. H. Ronka, T. T. Towles.

SCHWEDLER, WILLIAM MAX, Jun., Boston, Mass. (Elected March 14, 1927.) (Age 32.) Student, Graduate School of Business, Harvard Univ. Refers to J. D. Fowler, A. G. Hayden, L. G. Holleran, O. H. Koch, J. G. McKenzie, G. T. Seabury.

STEMM, HOWARD JOHN, Jun., National Stock Yards, Ill. (Elected Feb. 10, 1930.) (Age 32.) Engr., Swift & Co., National City, Ill. Refers to R. P. Black, J. H. Johnston, C. M. Staymaker, C. A. Smith, F. C. Snow, J. E. Vollmar.

VICENTE, ELISIO FERREIRA, Jun., Woodhaven, N.Y. (Elected Oct. 26, 1931.) (Age 32.) Structural Engr. with James E. Geissberger, Cons. Engr., New York City. Refers to J. J. Ashton, W. G. Grove, S. Johnston, M. C. Knabe, 3d, G. E. J. Pistor.

WOLF, CLEMENS WILLIAM HENRY, Jun., Jackson, Mich. (Elected Feb. 24, 1931.) (Age 30.) Res. Engr. with Fargo Eng. Co. Refers to W. G. Fargo, H. L. Fruend, G. B. Gascoigne, H. S. Hunt, A. Streiff.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; New York state license; with 20 years experience in construction and maintenance of highways; 22 months supervising construction and repair of dams, sewers, fire stations, airports, and recreation and athletic fields, redecorating buildings, etc., a number being done at same time. Fully capable of organizing and handling men. D-4669.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; graduate C.E.; 30; married; 8 years diversified experience in railroad, bridge, and municipal construction; last 2 years construction superintendent on dam and water supply project. Desires position with active engineering or construction organization offering some permanency and opportunity for future. D-4718.

CIVIL AND MINING ENGINEER; Jun. Am. Soc. C.E.; 32; married; A.B. and C.E. degrees, Cornell University; 10 years experience, engineering, construction, open-pit mining, steel and concrete construction, railroad location, surveying, and mapping; large-scale excavations, ore and rock haulage; dragline operations, hydraulic mining; cost accounting, preparation of reports. Excellent references. D-2252.

EXECUTIVE

GRADUATE SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; licensed professional engineer; 10 years in design and construction of sewage treatment works and sewers; 1 year as superintendent of construction; 2 years manufacturing and promoting concrete pipe; 1 year selling mechanical equipment for sewage treatment plants; at present employed. Desires connection where all-round experience is essential. C-874.

CIVIL ENGINEER; M. Am. Soc. C.E.; 40; university graduate; 9 years experience: design of sewerage; preparation of plans, estimates, specifications, and contracts for work costing $24,000,000; precipitation studies; hydraulic experiments; reports. Five years experience: construction of roads, buildings, water supply, sewerage, railroads, and docks; flood control. Desires responsible position, design, construction. Available soon. D-1132.

EXECUTIVE ENGINEER; M. Am. Soc. C.E.; 40; married; 30 months as executive, Civilian Conservation Corps; 12 years designing and constructing buildings of factory type; 3 years surveying and construction, New York State Barge Canal. Available immediately. Location immaterial. C-7203-362-A-7-San Francisco.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; with experience in real-estate development and subdivision (complete improvements), building dwelling houses and large apartments, also water supply and sewage construction. Highway construction and experience in municipal engineering. D-4644.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; self educated technically with assets of practicality, industry, and integrity; has designed and supervised building of water works, hydroelectric power plants, railroads, and steel plants; now wishes position of responsibility and trust. B-5199.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 32; graduate of University of Michigan; licensed New York; 11 years experience in design, construction, and appraisal of building structures as engineer and superintendent. Desires connection with contractor, financial institution, chain store, or theatre organization. Location immaterial. D-4668.

SPECIFICATION WRITER; Jun. Am. Soc. C.E.; university graduate in civil engineering; 30; 3 years as specification writer and author of general technical literature; 6 years additional as editor construction magazine, construction engineer, and estimator. D-4756.

CIVIL AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; 14 years varied engineering experience, including highway design and construction, municipal paving and sewer design and construction, water works supervision, city planning, surveying. Desires permanent position in any branch of civil engineering. Available on short notice. D-4748.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; degree at West Virginia University in 1934, with sanitary option, and structural studies; 1 year in design and construction of swimming pool, water purification equipment; 3 months surveying; desires position in any branch of civil engineering; location immaterial; available immediately. D-4678.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S. in C.E., New York University, 1934; majored in sanitary engineering; knowledge of Spanish. Desires position in any field of civil engineering, or in real estate management. Location and salary secondary. Available immediately. D-3870.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; B.S. C.E. in 1931; over 3 years varied engineering experience, including surveying, inspecting, research, and testing for U. S. Engineers, highways and city; licensed; desires permanent position in any branch of civil engineering. Location immaterial. Available immediately. D-4696.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; married; B.S. C.E., Cooper Union Night School, 1935; extensive courses in reinforced concrete construction; 4 years experience in municipal subway and highway construction; estimates; general field work. Prefers position with construction contractor, designer, or consulting engineer. Excellent references as to ability and character. Available immediately. Salary and location open. D-4687.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; B.S. C.E. 1928, C.E. 1933, University of Florida; 3½ years general surveys, office work, and reports; 2½ years executive position on railroad and levee construction; 1 year on ground-water surveys; 1 year in hydraulic experimental work and studies; 7 years with U. S. Engineers. Desires position with opportunities. Available immediately. C-4784.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; B.S. C.E., University of Southern California, 1932; 1 year in field and 2 years in office work with Metropolitan Water District of Southern California on Colorado River aqueduct. Desires position in vicinity of Los Angeles, San Francisco, Seattle, or New York City. Available on notice of one month. D-4744.